

RESEARCH

Bavarian German *r*-Flapping: Evidence for a dialect-specific sonority hierarchy

Erin Noelliste

University of Northern Colorado, World Languages and Cultures, Greeley, CO, US
erin.noelliste@unco.edu

In certain varieties of Bavarian German, where both liquids vocalize in the syllable coda, word-final sequences of /rL/ are realized with a flapped *r* as the onset to a syllable with nuclear syllabic *l* ([l̥]). In this article, I discuss one such variety of Bavarian German, presenting data and analysis of Bavarian German Flapping, as well as Liquid Vocalization. This paper argues that Bavarian German Flapping repairs a sonority plateau created by adjacent liquids; it is shown that Bavarian German necessitates its own unique sonority hierarchy, as opposed to one German-specific hierarchy (cf. Wiese 1996) or a universal hierarchy (cf. Parker 2008; 2011). There are several theoretical contributions of this paper: first, I show that in languages, such as Bavarian German, where two or more rhotics behave differently in terms of sonority, the language's sonority hierarchy must divide the class of liquids, specifically placing trills and flaps at different levels of sonority; I propose such a sonority hierarchy for Bavarian German. Additionally, this analysis engages with research on sonority which promotes universal sonority hierarchies determined via phonetics (cf. Parker 2008; 2011); the current analysis argues that such a universal sonority hierarchy cannot account for the Bavarian German data (i.e. Flapping). Finally, with the proposed dialect-specific sonority hierarchy, it is argued that sonority is emergent and not universal. While emergence has been widely discussed in particularly phonological and morpho-phonological literature (see Mielke 2008; Archangeli & Pulleyblank 2016), it has not been extended specifically to phonological sonority; thus, this is a central contribution of the article.

Keywords: rhotics; emergence; Bavarian German; sonority hierarchy; flap; trill

1. Introduction

The relative sonority of liquids is a matter of debate. Compare, for example, the German-specific hierarchy in Wiese (1996), where rhotics are more sonorous than laterals, to Parker's (2008; 2011) universal hierarchy, where flaps are more sonorous than laterals, which in turn are more sonorous than trills. In this article, I argue for a dialect-specific sonority hierarchy in which trills and laterals are more sonorous than flaps. This hierarchy falls out from Bavarian German data collected in Styria, Austria,^{1,2} which show the distribution

¹ While the data in this paper come from one town in Austria – Ramsau am Dachstein – the processes discussed are representative of many (although not all) regions of Bavarian German. See, for example, discussion in Kranzmayer (1956).

² The data for this study, which first appeared in Noelliste (2017), were collected from three speakers (two men and one woman), whose ages range from 35–50. Each subject speaks German natively and English as a second language, and has a high school education. The speakers converse in dialect in their daily lives, although each had training in Standard German throughout their schooling. Tasks for data elicitation included speakers reading aloud (in dialect) stimuli typed in Standard German consisting of wordlists, phrases, and sentences, as well as reading a typed noun and then producing the Bavarian German diminutive form of that noun. Each session was recorded on a Zoom H2 recorder and saved as a WAV file. The audio recordings were analyzed with the phonetic software Praat (Boersma & Weenink 2013) and transcribed into IPA. Transcriptions are based both on the sounds heard when the recordings are played aloud, as well as formants in the spectrograms.

of coda /R/ and /l/, as well as the word-final sequence /rɫ/. See representative data in (1), where liquids vocalize in a coda (1a–b) except for in the sequence /rɫ/, where they are realized with a flap and syllabic [ɫ] (see 1c).

- (1) Bavarian German *r* and *l*
- a. /R/ [tɔ̯ɐ] ‘gate’
 - b. /l/ [fɔ̯ɫ] ‘full’
 - c. /rɫ/ [kɛ.rɫ] ‘guy’

I argue that the surface realizations in (1) are the result of the interaction between rules of syllabification and principles of sonority (i.e. the Sonority Sequencing Principle (SSP) from Selkirk 1984). It is my claim that Flapping resolves a sonority plateau between an onset and nucleus ([rɫ]) because in Bavarian German, the flap [r] is less sonorous than the trill [R].

This paper offers several theoretical contributions. First, I show that for languages with two or more allophones of /R/ which behave differently in terms of sonority, the class of rhotics needs to be divided into trills and flaps. As only a handful of scholars have conducted research in this area, this is an important contribution to the field. Another theoretical contribution of this paper pertains to the cross-linguistic discussion of segmental sonority. Recent phonetic research on Romance languages has argued for a cross-linguistically impermutable sonority hierarchy, where the class of liquids is divided into multiple sonority levels: flaps > laterals > trills (see Parker 2008; 2011). This hierarchy cannot account for the Bavarian German data in (1), as the Bavarian German flap behaves as a less-sonorous sound than the lateral (i.e. the flap is the onset to a nuclear lateral). Therefore, the Bavarian German data are important because they pose a problem for arguments concerning universal segmental sonority. Finally, I argue that relative sonority is emergent and not innate (cf. earlier authors such as Hankamer & Aissen 1974; Steriade 1982; Suzuki 1989, who argue for language-specific sonority hierarchies). That is, the Bavarian German data necessitate a dialect-specific sonority hierarchy, as opposed to an impermutable universal hierarchy (cf. Parker 2008; 2011). Emergence has been widely discussed in the linguistic literature, particularly in terms of phonological features (Mielke 2008) and morphology (see Archangeli & Pulleyblank 2015; 2016 for references); however, to my knowledge, emergence in terms of phonological sonority is not represented in the literature.

The analysis presented here features data from a German dialect which engages in ongoing research concerning the significance of understanding rhotics via their phonological behaviors rather than phonetic properties (see other articles, this volume). The paper expands the discussion on emergence theory beyond features and morphology and into the realm of sonority, arguing that sonority in individual languages is not universal but rather emergent.

This paper is organized as follows: Section 2 provides a brief overview of Bavarian German phonology. In section 3, I present data and analysis for Bavarian German Liquid Vocalizations of /R/ and /l/, and in section 4, I discuss syllabic liquids. Section 5 features discussion of the Flapping of /R/. In section 6, I discuss the sonority of liquids, arguing for a dialect specific sonority hierarchy to account for the Flapping data; I also give independent evidence for the repair of another kind of Bavarian German sonority plateau, specifically that of Bavarian German nasals. Section 7 discusses emergence theory and argues for emergent sonority hierarchies. Section 8 concludes.

2. Overview of Bavarian German Phonology

The term “Bavarian German” refers to language spoken in the German state of Bavaria and most of Austria (Zehetner 1985: 58; Rowley 1990; Wiesinger 1990). Bavarian German as a whole is characterized by certain phonological, morphological, and syntactic differences from Standard German. For example, Standard German front rounded vowels (umlauted vowels) surface as front unrounded vowels throughout many regions of Bavarian German, so a word like Standard German *mögen* [møgən] ‘to like’ is realized as Bavarian German [meŋ] (see Wiesinger 1990: 452–456 for a list of Bavarian German traits). Some synchronic phonological and morphological changes apply to all or most of Bavarian German, while others differentiate the individual regions within Bavarian German. For example, Central Bavarian is characterized by Liquid Vocalization of coda /l/ (Zehetner 1985: 55–56); however, the effects of Liquid Vocalization of /l/ on preceding vowels differs, depending on geographical region. In Ramsau, front vowels surface as back before a vocalized /l/ (see Noelliste 2017: 147–156 for data and discussion), while in other areas of Styria, the sequence of front vowel and /l/ surfaces as a front rounded vowel. Compare, for example, the realization of the word *Milch* ‘milk’ as [mʊɪç] in Ramsau (Noelliste 2017: 148) with [my:ç] in other areas of Bavarian German (Vollmann et al. 2015: 21–22; see also Kranzmayer 1956; Wiesinger 1990: 474). There is variation in Liquid Vocalization of the Bavarian German rhotic, as well, where authors such as Rowley (1990: 423–4) and Wiesinger (1990: 459) record vocalization of coda /r/, while Hall (2009: 4) cites a lack of vocalization with /r/ in Imst German, a Southern Bavarian variety recorded by Schatz (1897).

The consonant and vowel inventories of the Central Bavarian German variety described in this paper (henceforth Bavarian German) are provided in (2) and (3). The consonants given in (2) are phonemic, except for the flap, which is an allophone of /r/, and the palatal fricative [ç], which is an allophone of /x/. Both allophones are given in square brackets, denoting their allophonic status.

(2) Bavarian German Consonant Inventory

OBSTRUENTS				
VCLESS STOPS	p	t		k
VC STOPS	b	d		g
AFFRICATES	pf	ts	tʃ	
VCLESS FRICATIVES	f	s	ʃ	[ç] x
VC FRICATIVES	v			
SONORANTS				
NASALS	m	n		ŋ
LIQUIDS		l	[r]	R

The phonemic vowels are given in (3), where (3a) contains phonemic monophthongs and (3b) phonemic diphthongs. It is important to note in (3a) that there are no front rounded (umlauted) vowels in this dialect in any context (cf. similar varieties discussed in Wiesinger 1990).³

³ The vowels in the data provided in this paper are not marked for length. I am thankful to an anonymous reviewer for pointing out that in a study concerning word minimality, it would be difficult to capture the minimal word requirement (see, for example, Hall 1999, for discussion of this principle concerning Standard German). However, the present study focusses on features and sonority of sonorant consonants and is not concerned with syllable weight (and syllable weight has no direct effect on the analysis explored here). This question is therefore left open to future research.

(3) Bavarian German Vowel Inventory

a. Phonemic Monophthongs

	FRONT		BACK	
HIGH	i	ɪ	ʊ	u
MID	e	ɛ	ə	ɔ
LOW	a			

b. Phonemic Diphthongs

	FRONT	BACK
HIGH		
MID		ɔ̩
LOW	a̩	a̩

The consonant and vowel inventories in (2–3) will be used in the following sections to discuss several phonological processes in Bavarian German and their theoretical implications.

3. Liquid Vocalization

In Bavarian German, there is a productive process of Liquid Vocalization of /l/ (first discussed by Schmeller 1821: 107–110; see also Kranzmayer 1956: 119–121; Zehetner 1985: 55–66; Wiesinger 1990; Merkle 2005: 23–24; Noelliste 2017)⁴ and of /r/ (see Hall 1992; 1993; Wiese 1996 for SG), whereby coda /l/ and /r/ are realized as the glides [ɫ̩] and [ʀ̩], respectively. Representative examples of this are given in (4a, b).

(4) Liquid Vocalization

a.	[meʀ̩ ~ me.ʀə]	Meer ~ Meere	‘sea(s)’
	[fə.liʀ̩n ~ fə.li.ʀɐ]	verlieren ~ Verlierer	‘to lose ~ loser’
	[ʃtuʀ̩ ~ ə [tu.ʀɐ e.s]]	stur ~ ein sturer Esel	‘stubborn ~ a stubborn donkey’
b.	[ʃpuɫ̩ ~ ʃpu.lɐ]	spulen ~ Spuler	‘to wind ~ winder’
	[fɔ̩ ~ fɔ.lɐ]	voll ~ voller	‘full ~ fuller’
	[ɛ.tsɔ̩n ~ ɛ.tse.lɐ] ⁵	erzählen ~ Erzähler	‘to narrate ~ narrator’
c.	[lɪçt]	Licht	‘light’
	[ʃlo.fm]	schlafen	‘to sleep’
	[fə.liʀ̩n]	verlieren	‘to lose’
d.	[ʀo.man]	Roman	‘novel’
	[ʃpre.çŋ]	sprechen	‘to speak’
	[pa.ra.lɐ.lɐ]	paralleler (M.NOM)	‘parallel’

In (4a), [ʀ] alternates with [ʀ̩] in words such as *Meer* and *Meere*, where the consonant surfaces in an onset and the glide in a coda. The same can be seen with the lateral in (4b), where [l] surfaces in onset position, and the glide [ɫ̩] is realized in a coda. Non-alternating examples of liquids can be seen in (4c–d), where /l/ surfaces as the consonant [l] in an onset, consonant cluster, and a word-internal onset without a vocalized counterpart in (4c), and /r/ surfaces as consonantal [ʀ] in the same syllabic positions in (4d).

⁴ While Liquid Vocalization was recorded at earlier historical stages of Bavarian German dialects (cf. Schmeller 1821), it is considered a productive process in this dialect, as it occurs within new words in the language.

⁵ It can be seen in this example that the vowels [e] and [ɔ] alternate before an underlying /l/. The interested reader is referred to Noelliste (2017) for discussion of how this vowel alternation can be addressed in line with the current analysis.

Based on these descriptions, Liquid Vocalization can be formulated with the rules in (5): The rhotic /R/ is realized as [ɤ] in a coda (see (5a)); the lateral /l/ is realized as [ɭ] in a coda (see (5b)).

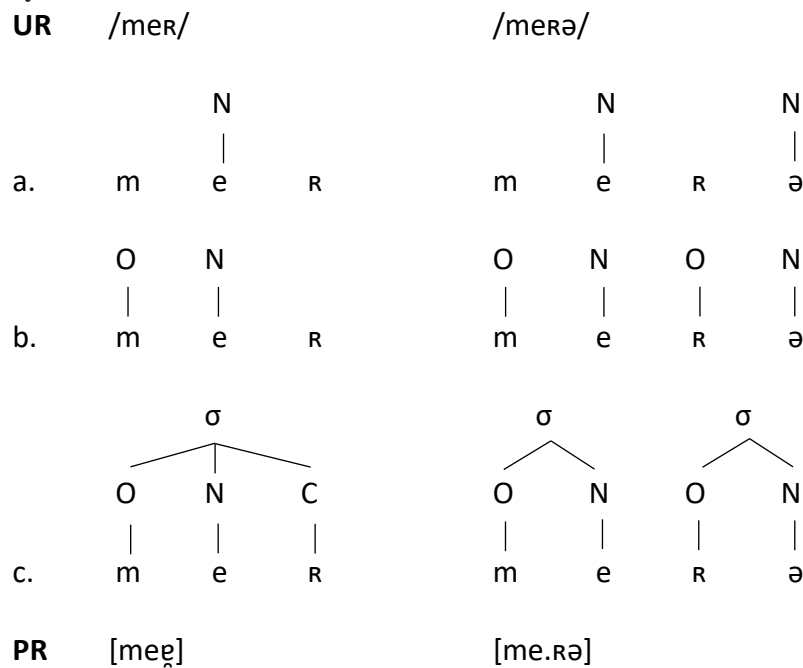
- (5) Liquid Vocalization
- a. /R/ → [ɤ] / V __ (C)]_σ
 - b. /l/ → [ɭ] / V __ (C)]_σ

The output of Liquid Vocalization of /l/ ([ɭ]) is a non-syllabic element; it is the second part of a diphthong, which I define as a syllabic vowel plus a non-syllabic vowel (glide), which are tautosyllabic. The output of Liquid Vocalization of /R/ is likewise a non-syllabic vocalic element – a glide ([ɤ]). As can be seen in the data in (4), the context of Liquid Vocalization is a syllable coda. Thus, rules for syllabification which determine onsets, nuclei, and codas must be considered before a final analysis of Liquid Vocalization can be formulated. The steps for Syllabification are given in (6).⁶

- (6) Syllabification (adapted from Kenstowicz 1994: 253–4; Wiese 1996: 52–53)
- a. Parse [–consonantal] segments in the nucleus.
 - b. Create onsets, obeying wellformedness constraints for syllabic structure.⁷
 - c. Create codas, obeying wellformedness constraints for syllabic structure.

Step (6a) specifies that a nucleus is assigned via Syllabification, and steps (6b–c) create well-formed clusters (as defined in terms of sonority). Syllabification is applied to the words *Meer* and *Meere* in (7). In steps (7a–b), nuclei and onsets are created, respectively. In step (7c), /R/ is assigned to the coda in *Meer*, while it is already in an onset in *Meere* (via (7b)); thus, the /R/ in *Meer* undergoes Liquid Vocalization, but the onset /R/ in *Meere* does not (cf. the phonetic representations at the bottom of (7)).

(7) Syllabification of *Meer* and *Meere*



⁶ Although I adopt a rule-based framework here, I take a theory-neutral stance on these general principles of syllabification; that is, the same principles could be formalized within various frameworks. For more discussion on the syllable and syllabification in various frameworks, see Zec (2007) and Goldsmith (2014).

⁷ See discussion of the Sonority Sequencing Principle in section 4.

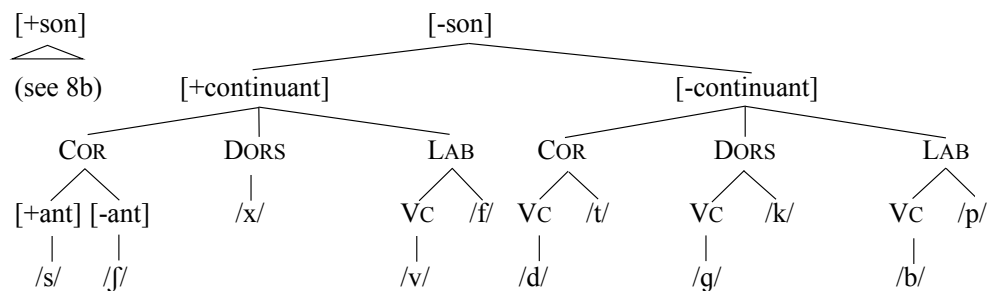
The output of Syllabification creates the context for Liquid Vocalization, which is analyzed here using features (Sagey 1986; McCarthy 1988; see also Hall 2007; Mielke 2011 for more recent discussion). The features used in the current article follow the analysis in Noelliste (2017); the feature system was proposed specifically for this variety of Bavarian German, and features were determined via a contrastive hierarchy (see Drescher 2009 and references therein). Under the contrastive hierarchy framework, the way in which languages assign features to segments depends on contrasts present in that language; thus, the feature hierarchy which is best for a given language depends on that individual language’s phonological behavior, e.g. /p t k/ in a language in which those sounds are the only stops are analyzed differently than /p t k/ in a language in which there are also /b d g/. There are three central concepts of Drescher’s (2009) framework, including: the Successive Division Algorithm (SDA) (Drescher 2003; 2008), which is an algorithm for determining contrastive specifications in a language; the Contrastivist Hypothesis, which states that “only contrastive feature specifications are active in the phonology” (Drescher 2009: 75) (see also discussion in D. C. Hall 2007: 20); and the Modified Contrastive Specification (MCS), which Drescher (2009) explains is a combination of the Contrastivist Hypothesis and the contrastive hierarchy. Drescher (2009: 163–164) describes MCS as follows:

In this model, complexity in representations is driven by both contrast and markedness. Assuming that each feature has a marked and unmarked value, MCS posits that only marked features count toward complexity; thus, segments with fewer marked features are less complex than those with more marked features. MCS proposes that contrasts are determined by the SDA operating on a hierarchy of features. Since a more marked representation is permitted only if needed to establish a contrast with a less marked one, the theory of MCS leads us to expect a relation between the amount of segmental markedness a system allows and the number and nature of contrasts it has.

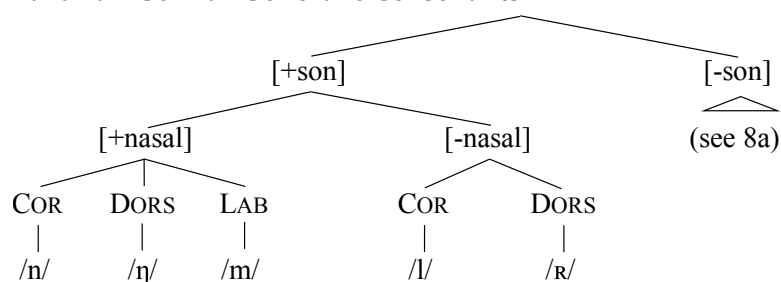
The MCS framework was applied to Bavarian German phonemes in the hierarchies in (8–9) to determine contrastive features for Bavarian German; all consonants are [+consonantal] and all vowels [–consonantal]. It is important to note that, in using a feature hierarchy, not all segments are specified for each potential feature. For example, the feature [continuant] is only distinctive for obstruents in (8a) and not sonorants in (8b). Likewise, [nasal] is distinctive only for sonorants and not obstruents. When a segment is not contrastive for a certain feature, it has no specification for it. For example, only coronal fricatives contrast in terms of the feature [anterior]; thus coronal fricatives have specifications for [anterior], but the coronal stops /t/ and /d/ do not.

- (8) Hierarchy for Contrastive Features of Bavarian German Consonants:
 [sonorant] > [continuant], [nasal] > DORSAL, CORONAL, LABIAL > [anterior], [voice]

a. Bavarian German Obstruents

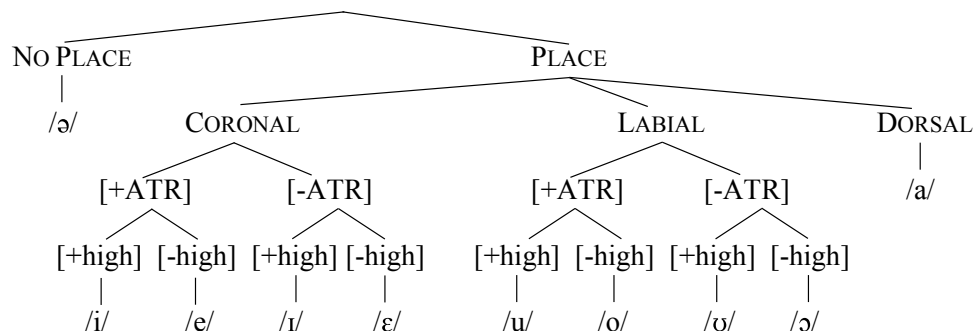


b. Bavarian German Sonorant Consonants



The contrastive hierarchy for Bavarian German vowels is given in (9). In this hierarchy, all vowels are [+sonorant] (and [-consonantal]), and they are distinguished by their PLACE features (CORONAL, DORSAL, and LABIAL), as well as feature values for height ([+/-high]) and tenseness ([+/-ATR]). I follow Pulleyblank (1988); Hume (1992); van de Weijer (1994: 38ff); Clements & Hume (1995); Rice (1995); Robinson (2001); and Glover (2014) in analyzing front vowels as CORONAL.

- (9) Hierarchy for Contrastive Features of Bavarian German Vowels:
 PLACE > CORONAL, LABIAL, DORSAL > [ATR] > [high]



Each non-syllabic vocalic segment (i.e. off-glides of diphthongs and vocalized liquids) has its own root node as well as its own set of place features. The diphthong /aɪ/, for example, is comprised of the features for /a/ next to those for /ɪ/; the former segment is [+sonorant, -consonantal, DORSAL], and the latter segment is [+sonorant, -consonantal, CORONAL]. Since there is no contrast between /aɪ/ and a diphthong such as */æɛ/, the only place feature needed for the second element when it is /ɪ/ is CORONAL; [high] is redundant. That is, because there is no contrast between a non-syllabic high coronal and a coronal at another height, the /ɪ/ in the diphthong /aɪ/ is not distinctive for [high]. In contrast, the monophthong /ɪ/ must bear the feature [+high] (cf. (9)) because it contrasts with /ɛ/. The same point holds for [ATR] because there is no contrast between /aɪ/ with a tense /i/ and /aɪ/ with a lax /ɪ/. The main difference between CORONAL monophthongs and the /ɪ/ component of the diphthongs is that the CORONAL monophthongs have feature values for both [high] and [ATR], while the /ɪ/ segment in diphthongs does not. Thus, there is only one non-syllabic front vowel option for diphthongs, so it is not important to state other phonological features of this vowel, since they vary with each utterance but still maintain their distinguishing feature CORONAL. The same principles hold for offglides produced through Liquid Vocalization: the vocalic outputs of this rule only contain relevant place features; i.e. [ɪ̥] and [ɛ̥] are only specified in terms of the places of CORONAL and DORSAL, respectively.

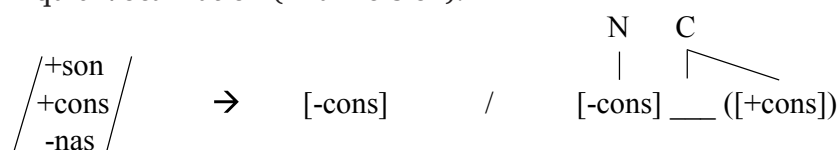
Feature matrices for the liquids /l/ and /r/, as well as their vocalized counterparts, are given in (10). It can be seen in (10) that the difference between [l] and vocalized [ɪ̥] is the value for the feature [consonantal]. Likewise, the only difference between [r] and vocalized [ɛ̥] is also the value for the feature [consonantal].

(10) Features of liquids and their vocalized forms

	/l/	[l̥]	/R/	[ɾ]
[sonorant]	+	+	+	+
[consonantal]	+	-	+	-
[nasal]	-	-	-	-
PLACE	✓	✓	✓	✓
CORONAL	✓	✓		
DORSAL			✓	✓

I argue that Liquid Vocalization involves only the change in the feature [consonantal]. That is, place features do not change when the liquids /l/ and /R/ become [l̥] and [ɾ].⁸ Given the features in (10), the final version of Liquid Vocalization can be stated as in (11).

(11) Liquid Vocalization (final version):



Liquid Vocalization states that a liquid (non-nasal sonorant consonant) becomes [-consonantal] when it is in a coda (i.e. follows a nuclear vowel). Liquid Vocalization makes no reference to place because when a liquid vocalizes, it retains its place features.

Additional support for the place features of the liquids proposed here comes from their interaction with the dorsal fricative. As in Standard German, Bavarian German has a process of Dorsal Fricative Assimilation, whereby the dorsal fricative is realized as palatal [ç] following coronal (i.e. front) sounds and as velar [x] following dorsal (i.e. back) sounds (for discussion of Standard German, see Wiese 1996). The data in (12a) show that when the Bavarian German dorsal fricative follows the lateral /l/, the palatal fricative surfaces, while after the uvular trill /R/, the velar fricative surfaces in (12b). I follow Noelliste (2017: 156–160) in considering these Bavarian German data as an assimilation of the dorsal fricative to the place of the preceding liquid. In order for these data to surface in this way, the lateral (and its vocalized counterpart) is necessarily specified as CORONAL, and the trill (and its vocalized counterpart) is specified as DORSAL.

(12) Dorsal Fricative Assimilation (Noelliste 2017: 156–157)

- a. Sequence of /lx/
 - [mɔɪç] Milch ‘milk’
- b. Sequence of /RX/
 - [ʃtɔɐx] Storch ‘stork’

Although southern German rhotics are often described as historically CORONAL [r], I argue that the Bavarian German rhotic trill functions as DORSAL phonologically. Even though some Bavarian speakers pronounce the consonantal rhotic as [r] today, many of these same speakers still have vocalization of /l/ which is realized as CORONAL [l̥].⁹ Additionally, in the context of Dorsal Fricative Assimilation in (12), the palatal fricative only surfaces after /l/, and not after the rhotic; if the rhotic functioned phonologically as CORONAL, one would expect the palatal [ç] to surface after it. Thus, the data in this section suggest that even though the phonetic implementation of the trill may be CORONAL [r] in

⁸ Contrast is retained for /R/ and /l/ when they surface as vocalized [ɾ] and [l̥] after back vowels; compare, for example, the words *Tor* ‘gate’ and *voll* ‘full’, which are produced as [tɔɐ] and [fɔɪ] respectively (Noelliste 2017: 132).

⁹ For an overview of modern Bavarian German dialects, see Rowley (1990) and Wiesinger (1990).

certain varieties, the Bavarian German rhotic trill functions as DORSAL, regardless of the phonetic place of articulation. Under this analysis where Bavarian German rhotics function as phonologically DORSAL, CORONAL may not be a necessary feature for Bavarian German rhotics, even if they were historically CORONAL.

In contrast to the liquids discussed in this section, which were in the coda, the next section deals with the realization of liquids when they are syllabic in nature; i.e. when they surface as the syllable nucleus.

4. Syllabic Liquids

Bavarian German sonorant consonants (liquids and nasals) occur frequently in coda clusters. See, for example, the data in (13).¹⁰

- (13) Possible Word-Final Consonant Clusters
- a. /R/-consonant
 /-rt/ [ɔʁt] Ort ‘place’
 /-rm/ [ɔʁm] Arm ‘arm’
 - b. /l/-consonant
 /-ld/ [bʊld] Bild ‘picture’
 /-lm/ [fʊlm] Film ‘film’
 - c. nasal-obstruent
 /-nd/ [kɪnt] Kind ‘child’

Each example in (13) conforms to the SSP (see Selkirk 1984; Blevins 1995; Zec 2007; Parker 2011) in (14) and the sonority hierarchy in (15); i.e. each example shows a fall in sonority from the nucleus to the coda.

- (14) **Sonority Sequencing Principle:** A syllable rises in sonority from the onset to the highest point, the nucleus, and falls in sonority to the coda.
- (15) General Sonority Hierarchy (Clements 1990)
 vowels > glides > liquids > nasals > obstruents

Considering the data in (13), a more exact generalization can be made concerning codas; this is given in (16). The Coda Generalization is essentially a subset of the SSP, tailored specifically to codas.

- (16) **Coda Generalization:** Coda clusters must fall in sonority.

In contrast to the data in (13), when a final consonant cluster rises in sonority, that final consonant will not be able to be parsed as a coda without violating the Coda Generalization (i.e. the SSP). See, for example, the data in (17).¹¹ Following authors such as Hall (1992; 1993) and Wiese (1996), I analyze words, such as those in (17a) in which /r/ vocalizes syllabically, with one underlying segment for [ɐ], rather than two segments (i.e. /ər/). While some authors (see, for example, Moulton 1962) apply the two-segment underlying model, the phonological behavior of this dialect does not necessitate an extra underlying segment; that is, these impossible word-final clusters can be repaired through syllabification processes (cf. Hall 1992; Wiese 1996), and I therefore analyze this dialect with the simpler

¹⁰ While I do not give an entire list of all possible combinations of coda clusters, a word such as (13c), for example, is representative of the combination of nasal plus obstruent. There is no implication that every obstruent can occur after every nasal.

¹¹ As with the data in (13), the words in (17) are representative of these types of combinations; this list is not exhaustive.

underlying representation of /r/. The same reasoning applies for the data in (17b–c), where there is an underlying sequence of consonants; i.e. schwa is not given as underlying.¹²

- (17) Impossible Word-Final Consonant Clusters
- a. consonant-/r/
 - /-dR/ [brʊ.dɐ] Bruder ‘brother’
 - /-mR/ [tsɪ.mɐ] Zimmer ‘room’
 - /-lR/ [ʃpi.lɐ] Spieler ‘player’
 - b. consonant-/l/
 - /-tʎ/ [ti.tʎ] Titel ‘title’
 - /-ŋʎ/ [ɛ.ŋʎ] Engel ‘angel’
 - /-rʎ/ [kɔ.rʎ]¹³ Karl ‘Charles’
 - c. obstruent-nasal
 - /-tn/ [ro.tŋ] raten (INF) ‘to guess’

Each cluster in (17) either rises in sonority (e.g. /-dR/ in (17a)) or exhibits a sonority plateau (e.g. /-lR/ in (17a)); thus, these clusters would violate the Coda Generalization if they were parsed as coda clusters. As shown in the data in (17), when a final sequence of consonants does not exhibit a sonority fall, then the second consonant is syllabic. These final sonorants that are unable to be syllabified without violating the SSP are syllabified via Sonorant Syllabification in (18).¹⁴

- (18) **Sonorant Syllabification:** When a sonorant cannot be parsed into a preceding syllable, it is assigned a nucleus.

Sonorant Syllabification can be seen in (17b–c) for /l/ and /n/. However, there is an additional change when /r/ is made syllabic: syllabic /r/ is realized as the vowel [ɐ]. The rule in (19a) accounts for that change. It states that an /r/ which is in the syllable nucleus (N) is realized as [ɐ]. Syllabic R-Vocalization is also given with features in (19b).

- (19) Syllabic R-Vocalization
- a.

/r/	→	[ɐ]	/	$\frac{N}{ }$
-----	---	-----	---	---------------
 - b.

$\left/ \begin{array}{l} +\text{son} \\ +\text{cons} \\ \text{DORS} \\ -\text{nas} \end{array} \right/$	→	[-cons]	/	$\frac{N}{ }$
---	---	---------	---	---------------

Syllabic R-Vocalization is different from Liquid Vocalization in terms of the environment of the rule; Liquid Vocalization occurs in the syllable coda (i.e. after the stem vowel), while Syllabic R-Vocalization occurs when /r/ is in the syllable nucleus. Thus, the outputs of these two rules are different: Liquid Vocalization produces a glide (in the coda), while Syllabic R-Vocalization produces a vowel (in the nucleus).

¹² I follow Hall (1992: 33–37) and Wiese (1996: 242–248), who argue for underlying forms without schwa in Standard German for these types of consonant clusters. Their analyses are based on alternations of schwa and zero within one morpheme, such as the morpheme /a:tm/, which can be realized with schwa as *Atem* [a:təm] ‘breath’ or without schwa as *Atmung* [a:t.mʊŋ] ‘breathing’ (Hall 1992: 34). Wiese (1996: 243) gives a similar alternation with the rhotic (*Filter* ~ *Filtr* + *at*), which lends support for his analysis of these clusters without underlying schwa. As in my analysis, the consonant clusters in Hall (1992) and Wiese (1996) are repaired through syllabic processes, rather than through schwa deletion in an example such as *Atmung*.

¹³ The flap allophone of /r/, which surfaces before syllabic /l/, will be discussed in the following section.

¹⁴ See Hall (1992: 35) for a similar analysis in Standard German.

After Sonorant Syllabification applies to a word, consonants preceding a syllabic sonorant are re-syllabified as an onset to that syllable.¹⁵ This step is shown as Resyllabification¹⁶ in the derivation in (20), which illustrates the steps for syllabifying word-final sonorant consonants. (20a) contains a coda cluster falling in sonority; thus it adheres to the Coda Generalization. (20b) contains a consonant cluster with rising sonority ([tl]), while (20c) shows a sonority plateau ([lr]) of the final consonants. Since the final sonorants in (20b–c) would violate the Coda Generalization if both consonants were parsed in the coda, the second word-final sonorant in each word cannot be parsed by Syllabification alone. These sonorants consequently undergo Sonorant Syllabification, and the preceding consonants are re-syllabified into the onset (Resyllabification). (20c) shows that *Spieler* also undergoes Syllabic R-Vocalization, and (20a) displays Liquid Vocalization in *spulen*.

(20) Syllabification of Sonorants¹⁷

	a. 'to wind' UR /ʃpuːln/	b. 'title' /titl/	c. 'player' /ʃpiːlɐ/
	$\begin{array}{c} \sigma \\ \\ N \\ \\ \text{ʃ p u l n} \end{array}$	$\begin{array}{c} \sigma \\ \\ N \\ \\ \text{t i t l} \end{array}$	$\begin{array}{c} \sigma \\ \\ N \\ \\ \text{ʃ p i l ɐ} \end{array}$
Syll 1	$\begin{array}{c} \sigma \\ / \ \backslash \\ O \ N \\ \wedge \ \\ \text{ʃ p u l n} \end{array}$	$\begin{array}{c} \sigma \\ / \ \backslash \\ O N \\ \ \\ \text{t i t l} \end{array}$	$\begin{array}{c} \sigma \\ / \ \backslash \\ O \ N \\ \wedge \ \\ \text{ʃ p i l ɐ} \end{array}$
Syll 2	$\begin{array}{c} \sigma \\ / \ \backslash \ / \ \backslash \\ O \ N \ C \\ \wedge \ \ \wedge \\ \text{ʃ p u l n} \end{array}$	$\begin{array}{c} \sigma \\ / \ \backslash \ / \ \backslash \\ O N C \\ \ \ \\ \text{t i t l} \end{array}$	$\begin{array}{c} \sigma \\ / \ \backslash \ / \ \backslash \\ O \ N \ C \\ \wedge \ \ \wedge \\ \text{ʃ p i l ɐ} \end{array}$
Syll 3	$\begin{array}{c} \sigma \\ / \ \backslash \ / \ \backslash \\ O \ N \ C \\ \wedge \ \ \wedge \\ \text{ʃ p u l n} \end{array}$	$\begin{array}{c} \sigma \\ / \ \backslash \ / \ \backslash \\ O N C \\ \ \ \\ \text{t i t l} \end{array}$	$\begin{array}{c} \sigma \\ / \ \backslash \ / \ \backslash \\ O \ N \ C \\ \wedge \ \ \wedge \\ \text{ʃ p i l ɐ} \end{array}$
SS	-----	$\begin{array}{c} \sigma \ \sigma \\ / \ \backslash \ / \ \backslash \\ O N C N \\ \ \ \\ \text{t i t l} \end{array}$	$\begin{array}{c} \sigma \ \sigma \\ / \ \backslash \ / \ \backslash \\ O \ N \ C N \\ \wedge \ \ \wedge \\ \text{ʃ p i l ɐ} \end{array}$
Resyll	-----	$\begin{array}{c} \sigma \ \sigma \\ \wedge \ \wedge \\ O N \ O N \\ \ \ \\ \text{t i t l} \end{array}$	$\begin{array}{c} \sigma \ \sigma \\ \wedge \ \wedge \\ O \ N \ O N \\ \wedge \ \ \wedge \\ \text{ʃ p i l ɐ} \end{array}$
SRV	-----	-----	ʃpi.ɐ
LV	ʃpuːn	-----	-----
PR	[ʃpuːn]	[ti.tl]	[ʃpi.ɐ]

¹⁵ This follows a principle commonly discussed in phonological literature on syllables known as the Maximal Onset Principle (see Blevins 1995: 99 for an overview), whereby onsets are maximized before codas.

¹⁶ Compare to the Resyllabification Convention from Clements & Keyser (1983: 37), as well as discussion concerning Standard German in Hall (1992: 59–63) and Wiese (1996: 244).

¹⁷ The following abbreviations are used for the rules: Syll = Syllabification, SS = Sonorant Syllabification, Resyll = Resyllabification, SRV = Syllabic R-Vocalization, LV = Liquid Vocalization.

Another instance when a syllabic liquid surfaces is the Bavarian German diminutive, which is the suffix [ɫ], e.g. *Häusl* for *Haus* (Merkle 2005: 106–109).¹⁸ Representative examples are given in (21).

(21) Diminutive Suffix¹⁹

a. Stem-final Obstruents

[grop ~ gra.bɫ]	Grab ~ Gräbl	‘grave ~ little grave’
[aŋ.ɡɛ.bot ~ aŋ.ɡɛ.bo.tɫ]	Angebot ~ Angebotl	‘offer ~ little offer’
[tok ~ ta.ɡɫ]	Tag ~ Tägl	‘day ~ little day’
[ɡrof ~ ɡra.fɫ]	Graf ~ Gräfl	‘count ~ little count’
[tɪʃ ~ tɪ.ʃɫ]	Tisch ~ Tischl	‘table ~ little table’
[reç ~ re.çɫ]	Reh ~ Rehl	‘deer ~ little deer’

b. Stem-final Nasal

[tsaʊn ~ tsɑɫ.nɫ]	Zaun ~ Zäunl	‘fence ~ little fence’
[RIŋ ~ RI.ŋɫ]	Ring ~ Ringl	‘ring ~ little ring’

The data in (21a–b) show the Bavarian German diminutive [ɫ] occurring after obstruents and nasals. When the diminutive is added to a stem, the morpheme-final consonant is re-syllabified as the onset of the following syllable ([ɫ]). For example, in the word pair *Tisch* ~ *Tischl*, the stem-final [ʃ] of *Tisch* is syllabified as the onset of the second syllable in *Tischl* [tɪ.ʃɫ].

As the data in this section show, syllabic liquids are realized differently in nuclei: the syllabic lateral is realized as consonantal [ɫ], while the syllabic rhotic undergoes the rule in (19) and is realized as vocalic. It is unclear why one liquid is realized as consonantal in a nucleus, while the other is realized as vocalic. One potential solution is that there is some restriction on word-final high vowels, which blocks syllabic [ɫ] from vocalizing in a nucleus. Another potential analysis is a restriction concerning manner, which blocks a trilled segment in a nucleus. For space reasons, I leave this question open for future research.

The next section deals with one particular type of word-final consonant cluster which results in a syllabic sonorant: the sequence /rɫ/, which is realized in Bavarian German with a flap allophone.

5. Flapping

Words such as *Spieler* in (17) show that the underlying sequence of the liquids /-lɾ/ is realized as [-lɐ] via Syllabic R-Vocalization in (19). The reverse sequence of /rɫ/, however, is different, as it surfaces with a flap allophone of /r/. For example, the word *Kerl* /kɛrɫ/ ‘guy’ is produced as [kɛ.rɫ] in Bavarian German. This differs significantly from the SG realization of *Kerl*, which is parsed as [.kɛrɫ.] because the /r/ and the /l/ form a legal coda cluster (Hall 1993; 2002; Wiese 1996). The /r/ then optionally undergoes R-Vocalization in SG, and the word surfaces as [kɛɾɫ] (or as [.kɛrɫ.]). The current section investigates these Bavarian German realizations of /rɫ/ as [ɾɫ] via a rule of Flapping.

Data with the Bavarian German flap in words ending in /rɫ/ are given in (22).

¹⁸ The realization of the diminutive suffix as [ɫ] is the Bavarian German reflex of SG *-lein* (e.g. *Häuslein*). See also Hall (2009), who analyzes a different Bavarian German dialect from Schatz (1897), in which the diminutive surfaces as [-lə].

¹⁹ No forms are present in my corpus with a stem-final labial nasal [m]. This is an accidental gap.

(22)	Word-final /-rɫ/		
	[kɔ.rɫ]	Karl	‘Charles’
	[kɛ.rɫ]	Kerl	‘guy’
	[kvi.rɫ]	Quirl	‘beater’
	[ʃmaj.kə.rɫ]	Schmankerl	‘delicacy’
	[ka.ʃpə.rɫ]	Kasperl	‘clown’
	[sa.kə.rɫ]	Sackerl	‘bag’
	[tsveɹ.gə.rɫ]	Zwengerl	‘munchkin’

It can be observed that when /rɫ/ is word-final, a flap allophone of /r/ surfaces as the onset of a syllable with [ɪ] as the nucleus. The data in (23) show that this occurs word-internally in the first part of a compound; in this context /rɫ/ is also realized as [rɫ].

(23)	Word-internal [rɫ]		
	[pɛ.rɫ.mʊt]	Perlmutt	‘mother of pearl’
	[vi.rɫ.pʊl]	Whirlpool	‘whirlpool’
	[fɔ.rɫ.bɛɹk]	Vorarlberg	‘Vorarlberg’
	[ɛ.rɫ.ki.nɪk]	Erlkönig	‘erl king’
	[ta.fə.rɫ.klas.lə]	Taferlklassler	‘first grader’
	[ʃtɛ.kə.rɫ.fɪ]	Steckerlfisch	‘fish on a stick’

I consider /r/ to be the underlying representation and not the flap because the latter sound has a restricted distribution. [r] occurs in an onset before syllabic [ɪ], while [ɹ] occurs in all other onset positions (i.e. elsewhere in onsets): word-initially, as in [ROT] ‘red’; word-internally, as in [le.Rɛ] ‘teacher’, and in a consonant cluster, as in [BRU.dɛ] ‘brother’. Data with alternations, such as those in (24), provide further evidence that the flap is an allophone of /r/. The data in (24) show that the realization of /rɫ/ with a flap also occurs across morphemes when the diminutive suffix [ɪ] attaches to a word ending in /r/. In these examples, the glide [ɹ] (via Liquid Vocalization in (11)) alternates with the flap [r].²⁰

(24)	Diminutive with Stem-Final /-r/		
	[aʊ.tog ~ aʊ.tɔ.rɫ]	Autor ~ Autorl	‘author ~ little author’
	[poɹ ~ pa.rɫ]	Paar ~ Pärl	‘pair ~ little pair’

When /r/ occurs before a non-syllabic /l/, /r/ undergoes Liquid Vocalization. For example, in words like *fehlerlos* ‘flawless’ and *natürlich* ‘naturally’, /r/ is syllabified in the coda, while the /l/ of *-los* and *-lich* is syllabified in the onset.²¹

Kranzmayer (1956: 124) describes data like those in (24) as being instances where *rl* is realized as *dl*, so the trilled *r* is realized more as a voiced obstruent, though he does not give IPA transcriptions (including syllabifications) for how this would be pronounced. It is clear that Kranzmayer is describing the process occurring in the data I give in (22–24); however, as shown in Noelliste (2017), Bavarian German [d] and [r] are different phonetically.

In contrast to the rhotic in the sequence /rɫ/, the lateral /l/ in /lR/ is not realized as a flap or some other allophone of /l/. Data showing sequences of /lR/ are presented in (25), where it can be observed that /r/ surfaces as the vowel [ɛ] (via Syllabic R-Vocalization), which is the nucleus of a syllable with initial [l].

²⁰ Recall the data in (4a), which contained examples of alternating [ɹ] and [ɹ̥]; compare, for example, the words *Meer* and *Meere* ‘sea’ and ‘seas’, which are realized as [mɛɹ ~ mɛ.Rə]. I suspect that there is a third realization for /r/ in this morpheme; namely, I believe the diminutive of *Meer* would be realized as [mɛ.rɫ].

²¹ I do not have these particular examples in my corpus, but I expect these sequences would behave in this way, considering the phonological patterning of the dialect discussed above. In the word *erstaunlich* ‘astonishing’, for example, the suffix *-lich* is parsed as described here: [ɛɹ.ʃtaʊn.lɪç].

- (25) Word-final /-lR/
 [ʃpi.lə] Spieler 'player'
 [ve.lə] Wähler 'voter'
 [fɔ.lə] voller 'fuller'
 [ʃvu.lə] schwuler (M.NOM) 'gay'
 [ʃtaɪ.lə] steiler (M.NOM) 'steep'

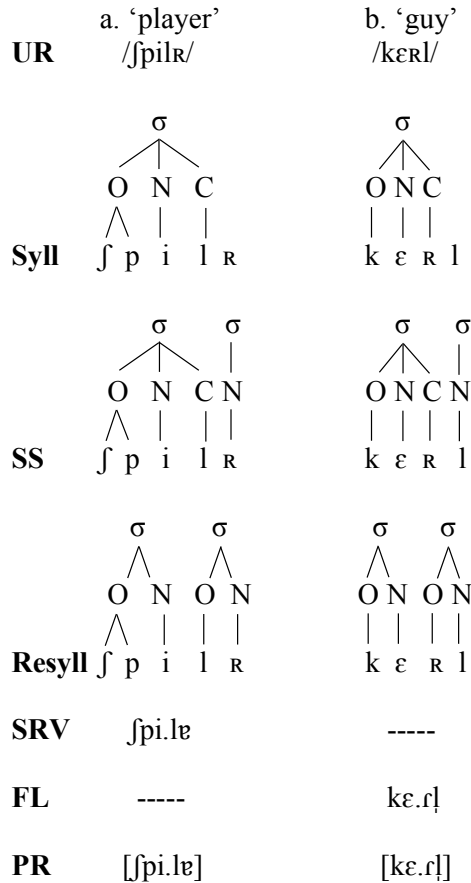
A rule which accounts for the flap allophone is given in (26).

- (26) Flapping

$$\left[\begin{array}{l} +\text{son} \\ +\text{cons} \\ -\text{nas} \\ \text{DORS} \end{array} \right] \rightarrow [r] / _ \llbracket \rrbracket$$

Flapping states that a dorsal sonorant non-nasal consonant (i.e. /R/) is realized as the flap [r] before a syllabic [l]. (27) incorporates Flapping in a derivation for sequences of underlying sonority plateaux with liquids. I do not divide Syllabification into the three steps; I simply give one output where all three steps have applied. In the first step, Syllabification cannot apply to /R/ in (27a) or /l/ in (27b) because Bavarian German does not allow for coda clusters to create a sonority plateau (cf. the Coda Generalization above). Therefore, Sonorant Syllabification applies to both words, followed by Resyllabification. Syllabic /R/ vocalizes in (27a), and /R/ undergoes Flapping in (27b) before a syllabic [l].

- (27) Sonority of /lR/ and /rL/²²



²² In this derivation, FL = Flapping; the other abbreviations used here are the same as those in (20).

Words ending in /r/ show that while Liquid Vocalizations are very prevalent in Bavarian German, /R/ does not vocalize before a syllabic [ɹ]. Instead, the sonority plateau /r/ surfaces with the realization of the flap allophone of /R/ in the syllable [r̩].

The only other existing phonological analysis of a similar process (of which I am aware) is Hall (2009), who analyzes data from another Bavarian German dialect described in Schatz (1897), where underlying /r/ is recorded as [dl] within and across morphemes. For example, the word *Kerl* is recorded as [kxɑ:dl] (Hall 2009: 16), which can be compared to the variety described here, where *Kerl* surfaces as [kɛ.r̩]. Hall analyzes this change from /r/ to [d] as a dissimilation of the feature [liquid], since the liquid /r/ is described as the obstruent [d] in the context of the adjacent liquids /r/. The data collected from the current dialect are very similar, where the same context – adjacent liquids /r/ – produces an output involving a change in the rhotic. These Bavarian German data clearly show, however, a surface flap, and not the obstruent [d] (cf. discussion above). Therefore, Bavarian German Flapping described here cannot be liquid dissimilation, as the trill /R/ (a liquid) is realized as a flap (also a liquid), in the sequence /r/. That is, [liquid] does not dissimilate when /r/ is realized as [r̩] because the output contains adjacent liquids, unlike in the analysis given in Hall (2009). If Flapping in the Bavarian German dialect described here were to be some kind of dissimilation, it is unclear which feature dissimilates, since it cannot be [liquid].

Considering the discussion above, an important question remains: Why does a flap allophone surface at all, particularly when this is the only position in the dialect where a flap is realized? The next section presents the solution that Flapping is a repair to the sonority plateau in the syllable [r̩], which is created by the output of Sonorant Syllabification and Resyllabification (cf. (27)). I follow recent literature (cf. Parker 2008) in analyzing the sonority of the rhotics [R] and [r] at different levels of the sonority hierarchy and propose a dialect-specific sonority hierarchy which can account for these Bavarian German data. Data for a repair of adjacent nasals provide additional evidence for how this dialect handles sonority plateaux of sonorant consonants.

An additional question concerns the place features of the Bavarian German rhotics [R] and [r]. In the Bavarian German data, Flapping changes a place feature, as the underlying DORSAL /R/ is realized as CORONAL [r]. This place change may be linked to a markedness constraint against uvular taps, which appear to be cross-linguistically rare (Wiese 2011).²³ Other potential rhotic allophones (e.g. the fricative [ʁ]), would require even more featural changes.²⁴ A similar situation is described in Lahrouchi (this volume), where the author describes data of French loanwords adopted into Moroccan Arabic and Berber, in which the French uvular fricative [ʁ] is realized as the coronal flap [r]. Lahrouchi argues that this adaptation is driven by phonotactics (i.e. phonology), and not the phonetic identity of the French uvular fricative. A comparable argument can be made for the flapping data here, where the Bavarian German phonology drives a change in the realization of the rhotic, and certain changes in features are the result.²⁵

²³ See Storto & Demolin (2012: 333–334) for discussion of this rare tap in the South American language of Kuikuro. I am grateful to an anonymous reviewer for this reference.

²⁴ Thanks go to an anonymous reviewer for this point.

²⁵ Another potential feature which changes in the process of Flapping is [continuant]. As a liquid, the flap is [+consonantal] and [+sonorant]. Recall that under the current analysis, sonorant consonants (including liquids) are not marked distinctively for the feature [continuant]; PLACE distinguishes between the liquids /R/ and /l/ (cf. the features in (10) and discussion about Dorsal Fricative Assimilation in section 3). If /R/ were marked as [+continuant] in the Bavarian German feature system, then Flapping could turn /R/ into a [–continuant] sound. Following Dresher (2009), according to the Contrastivist Hypothesis, distinctive features only apply to underlying segments and should not depend on allophonic processes (such as Flapping in Bavarian German). Flapping appears to be one of the instances where the Contrastivist Hypothesis in its purest form is too strong (Dresher 2009: 206–209); that is, specification for the feature [continuant] is needed for an allophonic process, even though it is not distinctive for underlying liquids. For discussion

Several other authors have discussed data describing differences within the class of rhotics between flaps and other *r* sounds. See, for example, Jatteau (this volume), who describes a situation in Ancient Greek, where root-initial trilled [r] is strengthened (geminated), and lenis *r* (the flap [r]) is restricted from surfacing word-initially. That is, the trill and flap behave differently in this language. Both articles mentioned above (Jatteau this volume; Lahrouchi this volume) lend support to the current analysis where the behavioral differences between a trilled rhotic and the flap [r] is phonologically (not phonetically) determined.

6. Sonority

6.1 Sonority of Liquids

Sonority has been widely discussed in the literature, and many authors have posited both language-specific, as well as universal sonority hierarchies to account for phonological behaviors of segments in various languages. For example, data such as SG *Kerl* /kɛrl/ [kɛɾl], where /r/ vocalizes before word-final /l/, have led scholars to posit the German-specific sonority hierarchy in (28).

- (28) German Sonority Hierarchy (Wiese 1996; Hall 2002):
vowels > glides > rhotics > laterals > nasals > obstruents

While this German sonority hierarchy is explanative for SG data, it cannot account for the Bavarian German facts, as words like *Kerl* from (22) have no Liquid Vocalization. Rather, words with the tautosyllabic sequence /rɫ/ are realized with two syllables, such as Bavarian German [kɛ.rɫ] *Kerl*.

Recent phonetic research on Romance languages (see Parker 2002; 2008; 2011: 1177)²⁶ has also argued for a unique sonority hierarchy, such as that given in (29). In this hierarchy, which is intended to be applicable cross-linguistically (i.e. it is universal), rhotics are divided into several classes of different sonority levels, with laterals between flaps and trills.

- (29) Cross-Linguistic Impermutable Hierarchy (Parker 2008):
...flaps > laterals > trills...

As is the case with the German sonority hierarchy in (28), a hierarchy such as (29) also cannot account for the Bavarian German data because in this hierarchy, flaps are more sonorous than laterals. That is, following (29), a syllable such as [rɫ.] would violate the SSP in (14), whereas the syllable [lɫ.] would be licit, as sonority would rise from the onset (trill) to the nucleus (lateral). The Bavarian German data, however, suggest that the opposite is true in this dialect: trills create a sonority plateau with laterals, and flaps are phonologically less sonorous than laterals. Thus, the sonority plateau [rɫ.] is repaired via Flapping, whereby the less sonorous allophone of /r/ (the flap) surfaces as the onset to nuclear [ɫ]. This solution requires that flaps be analyzed as less sonorous than /l/ in Bavarian German; therefore, I propose the dialect-specific sonority hierarchy for Bavarian German in (30).

- (30) Bavarian German Sonority Hierarchy
vowels > glides > trills, laterals > flaps > nasals > obstruents

of similar data in another language, see Hall & Hall (2016), who present an analysis in terms of ‘marginal’ contrasts, where contrast is seen to function on a continuum.

²⁶ The interested reader is also referred to Parker (2017), who presents a cross-linguistic metastudy on 264 recent studies of sonority.

It can be observed that in (30), liquids are divided into two separate sonority levels. Trills and laterals are equally sonorous, and they are more sonorous than flaps.²⁷ The Bavarian German sonority hierarchy is a cross between the general hierarchy in (15) and the cross-linguistic hierarchy in (29): liquids are mostly equally sonorous (as in 15), but flaps have a different sonority level than other rhotics (as in 29). However, in comparison to (29), the Bavarian German sonority hierarchy in (30) displays flaps as less sonorous than other liquids.²⁸

This analysis argues that the realization of Bavarian German /*r*/ as [ɾ] before /ɹ/ is a repair to a sonority plateau, which adjacent liquids create.^{29,30} In this way, the analysis supports understanding the sonority of rhotics via phonological, rather than phonetic behaviors. This argument is supported, in particular, by work such as Kostakis (this volume), where the author argues for analyzing historical rhotics through their phonological patterning (specifically the author discusses interactions of rhotics and vowels in Gothic Lowering and Old High German Primary Umlaut) rather than retrofitting modern phonetic evidence onto older stages of language. For more discussion on understanding rhotics in terms of phonology rather than phonetics, see particularly Lahrouchi (this volume) and Ulfsbjorninn (this volume).

6.2 Independent Evidence: Sonority of Nasals

In the analysis described above, the phonological process of Flapping was precipitated by a violation of the SSP in the form of a sonority plateau. This analysis derives support from another instance in this dialect where a sonority plateau of sonorant consonants is repaired; namely, the plateau created by adjacent underlying nasals surfaces as a nasal followed by schwa [ə]. This section is important because it shows that within the natural class of sonorants, both liquids and nasals repair a sonority plateau. For example, *schwimmen* ‘to swim’ does not surface as might be expected with a syllabic [ŋ] as *[ʃvi.mŋ]; rather, this word is produced [ʃvi.mə], where schwa – not the infinitive marker [ŋ] – is realized after stem-final [m]. This occurs in morphemes of various word classes, such as in verbs like *schwimmen* above. See, for example, the data in (31), where the verbal infinitives in (31a) show schwa after the stem, such as in the word *rennen*; however, the verbs in (31b), which have stems ending in coronal obstruents, surface with syllabic [ŋ] following the stem.

²⁷ The Bavarian German sonority hierarchy is considered dialect-specific because it differs from the Standard German sonority hierarchy in terms of how the liquids are represented. The Bavarian German sonority hierarchy is not simply a refinement of the Standard German sonority hierarchy, as it cannot account for the Standard German data. That is, a word such as Standard German *Kerl* /kerl/ would violate the SSP if the Bavarian German sonority hierarchy proposed here were active in Standard German.

²⁸ While the analysis here focuses on the relative sonorities of liquids, the complete Bavarian German sonority hierarchy proposed here accounts for data at other levels in the sonority hierarchy as well. That is, like the Standard German hierarchy proposed by Wiese (1996) and Hall (2002) (as well as the general hierarchy proposed by Clements 1990), in this Bavarian German variety, vowels are more sonorous than glides (cf. discussion in Noelliste 2017: 62–69, where diphthongs are argued to be falling, i.e. the first vowel falls in sonority to the glide), liquids are more sonorous than nasals (e.g. /spuln/ [ʃpuɫn] from (4)), which in turn are more sonorous than obstruents (e.g. words like [knt] from (13c)).

²⁹ Note that /-lɾ/, which is realized as [lɛ] in (17a), does not violate the SSP on the surface because every /*r*/ in the nucleus undergoes Syllabic R-Vocalization from (19).

³⁰ I am thankful to an anonymous reviewer, who suggests that a potential issue with the current account is that modern speakers may not be accessing a present-day sonority-based motivation for the rule of Flapping. As it is unclear when Flapping entered this dialect and I have no reason to believe the analysis adopted here was not active at an earlier stage, the sonority account for Flapping could have been in this Bavarian German dialect for many years. Since the current analysis focuses on the synchronic grammar of this dialect, I ultimately leave this question open to future research.

- (31) Bavarian German Infinitives
- a. Schwa

[ʃvi.mə]	schwimmen (INF)	‘to swim’
[ʀe.nə]	rennen (INF)	‘to run’
[si.ŋə]	singen (INF)	‘to sing’
 - b. Nasal Infinitive Marker

[ʀo.tŋ]	raten (INF)	‘to guess’
[vi.sŋ]	wissen (INF)	‘to know’

One might argue that the data in (31a) show that schwa is inserted after any word-final nasal. This cannot be the case, however, because there are many data where word-final nasals never have an epenthetic schwa following. For example, schwa is never epenthesized at the end of the words *Baum* [bam] ‘tree’ or *Regen* [ʀeŋ] ‘rain’. The data in (31) could be described via three analyses, which are listed in (32).

- (32)
- a. Vocalization of underlying /n/ to [schwa]. (to be rejected)
 - b. Phonologically-driven suppletive morphology, whereby the infinitive marker [n] surfaces after [-nasal] segments, while [ə] surfaces after [+nasal] segments.
 - c. Epenthesis of schwa between nasals followed by deletion of the infinitive marker /n/.

I assume that the analysis in (32a) is not possible, as one would expect vocalized /n/ to be necessarily realized as a [+nasal] vowel in all instances of /n/ Vocalization. This is not the case in Bavarian German,³¹ so I reject analysis (32a). The other two analyses in (32b–c) are equally plausible for Bavarian German phonology. For space concerns in the present article, I adopt analysis (32b), where there are two allomorphs of the infinitive marker: [n] and [ə]. Whether the morpheme /n/ surfaces as a consonant or schwa depends on the phonology; when /n/ follows a non-nasal segment, it surfaces as [n] (as in (31b)), and when /n/ follows a [+nasal] segment, it is realized as [ə] (as in (31a)).³² Analysis (32c) is equally illustrative for the data in (31), and this is the analysis adopted in Noelliste (2017), where there is a phonologically-driven repair to a sonority plateau which results in these data. While I adopt analysis (32b) here, I am agnostic as to which analysis ((32b) or (32c)) is correct because my main concern in this section is not about *how* to interpret these data, but rather *why* these data exist to begin with.

I argue that the data in (31) are motivated by the SSP from (14) working in tandem with the Bavarian German sonority hierarchy from (30). In the data in (31a), the underlying representations have adjacent nasals; for example, *schwimmen* is underlyingly /ʃvɪm-n/. The nasal sequence /m-n/ cannot be parsed as a coda without violating the SSP in (14), and hence those sounds cannot surface as [mn]. Instead, the adjacent nasals are made pronounceable by realization of the schwa infinitive allomorph of /n/. When an infinitive sequence does not violate the SSP, such as the word *kauen* [kaʊn] ‘to chew’, which ends in a vowel-nasal sequence, no repair (i.e. allomorphy) is necessary.

Word-final sequences like /tŋ/ in the word *raten* from (31b) also violate the SSP because nasals are more sonorous than obstruents. Such sequences undergo Sonorant Syllabification from (18), whereby a sonorant which cannot be parsed into a preceding syllable is assigned

³¹ For more data and discussion of Bavarian German nasalized vowels, see Noelliste (2017).

³² For other phonologically-driven morphological alternations in German, see, for example, discussion of *-heit/-keit* suffixation in SG (Wiese 1996: 90–100).

a nucleus. When Sonorant Syllabification applies, the preceding consonant is re-syllabified as the onset of that syllable. Thus, a word like *raten* is pronounced [ro.t̪].

Examples with nasal sequences which undergo infinitive allomorphy, together with Flapping, suggest that there is more than one repair in Bavarian German for sequences of underlying sonorant consonants in final position that are equally sonorous. That is, sections 6.1 and 6.2 show two different forms of repair to violations of the Bavarian German sonority hierarchy from (30). The data concerning nasals are important, as an avoidance of a sonority plateau is a property of the sonority hierarchy which is distributed within the class of sonorants; the data for liquids and nasals show that the sonorant consonants function together as a natural class. The natural class of obstruents behaves differently, in that coronal obstruents have been shown to appear in consonant clusters with other obstruents. See, for example, the data in (33) from Noelliste (2017: 44). These data show that a coronal stop occurs at the right edge of the word following another obstruent.

- (33) Extrasyllabic Obstruents
 [gɪpt] gibt (3.SG) 'to give'
 [frok̪t] fragt (3.SG) 'to ask'
 [luft] Luft 'air'

While these data might appear to be an issue for the analysis of sonorant consonants above, there are, however, independent reasons for why coronal obstruent clusters may behave differently from other kinds of consonant clusters. For example, many scholars have argued that in German and English, certain coronal obstruents are extrasyllabic at the word edge (for German, see Giegerich 1989; Wiese 1991; 1996; Hall 1992; for English, see Kiparsky 1981; Selkirk 1982; Clements 1990; see also van der Hulst 2014 for more recent discussion).³³ Wiese (1996: 265) describes extrasyllabic /s/ and /t/ in Standard German, stating: “[...] the unlimited possibility of adding /s/ and /t/ to another obstruent is obvious. This observation provides the argument for the extrasyllabic status of these coronals in word-final position. As extrasyllabic elements, these segments simply do not count in phonotactic matters such as those described by the sonority generalization.” I follow Wiese (1996), as well as the other authors listed above, that data such as those in (33) “simply do not count”, as far as the SSP goes. Therefore, such data do not pose a problem for the analysis for Flapping above.

7. Emergence

Much recent scholarship has looked at an Emergent Grammar, where various aspects of language emerge through the process of acquisition, rather than being universally or innately determined (cf. earlier theories, such as Universal Grammar from Chomsky 1965). This section seeks to bring sonority into the discussion of emergence, arguing that the Bavarian German sonority hierarchy is emergent and not innate, although beyond that, the paper leaves room for the continued debate about which properties are innate and which are emergent in phonology as a whole. The following text highlights several studies on linguistic emergence, including studies within the fields of phonetics, phonology, morpho-phonology, morphology, and syntax.

The analysis in Studdert-Kennedy (2000) argues for emergence of phonetic segments based on imitation and evolutionary principles, and articles such as Lindblom (1999) and Cole (2009) show phonological emergence in terms of its relation to phonetics. For

³³ See also Hall (2002) for a different analysis of these data.

example, Lindblom (1999: 206) writes that “For the child, phonology is not abstract. It represents an *emergent* patterning of phonetic substance.”

Some papers on phonological emergence argue for a broader, more general sense of emergence in phonological terms; see, for example, Harrison & Raimy (2007: 78), who describe emergence as a “philosophy of simplicity in analysis”, or Archangeli, Mielke, & Pulleyblank (2012) and Archangeli & Pulleyblank (2015) who argue for a phonological analysis in a more conceptually Emergentist Grammar. Other authors, on the other hand, delve into emergence more specifically in terms of particular studies within the field of phonology. For example, Schiering, Bickel & Hildebrandt (2010) discuss prosodic phonology and the relationship between word-related phonological properties and morphosyntactic structure. Perhaps most famously, Mielke (2008) discusses emergence in terms of phonological features, where features within a given language are dependent on that language’s phonology and not cross-linguistic universals. That is, following Mielke (2008), phonological features are emergent and not innate.

Other authors, such as Archangeli & Pulleyblank (2016; 2018), have examined the concept of emergence within the realm of morphology, arguing for a “bottom-up” model. Within this “bottom-up” framework, learners do not rely on more abstract principles, such as underlying representations, but rather, mental representations form via interaction with language and the perception learners develop (Archangeli & Pulleyblank 2016: 237). Simply put, in terms of the “bottom-up” model, the Emergent grammar is “driven by the data that the language learner encounters” (Archangeli & Pulleyblank 2016: 238).

Finally, Hopper (1987; 1998; 2004; 2011) has devoted many works to an Emergent Grammar within the field of syntax. He states that “Emergent Grammar focuses on the boundaries of categories rather than their prototypes, exploring the leading edges and the territory around them as they move [...]” (Hopper 2011: 28).

Several of the above authors, such as Harrison & Raimy (2007: 78) and Archangeli & Pulleyblank (2018) have called for the investigation of emergence in a broad spectrum of fields and methodologies. That is, as research on emergence continues to progress, the strength of an Emergentist Grammar (as opposed to UG) analysis lies in the expansion of studies on emergence to all linguistic fields and sub-fields. Archangeli & Pulleyblank (2018: 27) strongly state that: “Given the newness of emergent approaches to phonological patterns [...] virtually all areas of phonology and morphology demand research.”

In this vein, the current analysis of Bavarian German Flapping expands the concept of emergence, extending it to include phonological sonority and sonority hierarchies. In section 6, I argued for a unique sonority hierarchy for Bavarian German, and the fact that this hierarchy is dialect-specific alone indicates its status as non-universal and not innate. Earlier works, such as Hankamer & Aissen (1974); Steriade (1982); and Suzuki (1989), among others, considered sonority and sonority hierarchies to be language-dependent (see also Wiese 1996; Hall 2002, for German). However, particularly since the early 1990’s, universal scales, including scales concerning segmental sonority, have often (although certainly not always) been touted as the preferable means for analyzing sonority. See, for example, discussion of sonority within the framework of Optimality Theory (OT; Prince & Smolensky 1993; 2004) in de Lacy (2002; 2004; 2006; 2007). More recently, Parker (2008; 2011) has argued for universal hierarchies on the basis of phonetic grounds; however, the data for Bavarian German Flapping show that such universal hierarchies cannot be functional in Bavarian German. The Standard German sonority hierarchy, which accounts for the Standard German realization of *Kerl* with vocalized *r*, also cannot account for the Bavarian German realization of *Kerl* with the flap allophone. The present analysis maintains that no one sonority hierarchy or claim about the sonority of certain segments is universal; rather, sonority is language-dependent and perhaps best described in terms

of phonological interactions of segments within a given language. Following particularly Mielke's (2008) work with emergence of phonological features,³⁴ I therefore contend that sonority hierarchies, as well as the sonority of individual segments, are emergent within any given language.³⁵ Since emergence is currently being explored in many linguistic fields, perhaps it is an opportune time to revisit older scholarship (i.e. authors such as Hankamer & Aissen 1974; Steriade 1982; Suzuki 1989) in an effort to clarify the picture of sonority hierarchies.

8. Conclusion

In this paper, I have presented data for the Bavarian German process of Flapping and accounted for the flap allophone of /r/ by using the SSP and a dialect-specific sonority hierarchy. I have shown that one uniform German sonority hierarchy cannot account for the phonologies of Standard German and all German dialects. Another theoretical contribution of this paper is to the cross-linguistic discussion of segment sonority: although phonetic studies show flaps as more sonorous than laterals and trills in Romance languages, the data presented in this paper show that the Bavarian German flap behaves phonologically as less sonorous than the lateral; otherwise, the flap could not be the onset to a syllable with the lateral as a nucleus, according to the SSP. The present analysis argues for understanding rhotics through their phonological behaviors rather than through their phonetic properties. The paper thus engages with much recent discussion on this topic in the literature (see Kostakis this volume; Lahrouchi this volume; Ulfsbjorninn this volume). Finally, the paper argues against sonority being universal or innate. Instead, it considers a language's sonority hierarchy to be emergent (cf. works such as Mielke 2008; Archangeli & Pulleyblank 2015; 2016).

Abbreviations

3 = third person, ant = anterior, ATR = advanced tongue root, cons = consonantal, COR = coronal, DORS = dorsal, FL = Flapping, LAB = labial, LV = Liquid Vocalization, INF = infinitive, M = masculine, nas = nasal, NOM = nominative, PR = phonetic representation, Resyll = Resyllabification, SG = singular, son = sonorant, SRV = Syllabic R-Vocalization, SS = Sonorant Syllabification, SSP = Sonority Sequencing Principle, Syll = Syllabification, UR = underlying representation, VC = voiced, VCLESS = voiceless

Ethics and Consent

This study was approved by the Institutional Review Board (IRB) of Indiana University, Bloomington under the reference number 1207009077.

Acknowledgements

I would first like to thank the three speakers of this dialect who generously invited me into their homes and provided their time and the data for this study. Second, thanks go to Andrew Kostakis and Tracy Hall who gave support to this project, as well as critical feedback on previous versions of this work. Finally, I am thankful for the thorough comments, suggestions, and thoughtful feedback from three anonymous reviewers.

³⁴ Consider Mielke (2008: 8): "The idea that phonological classes are language-specific is consistent with language development-based arguments that phonological (Vihman and Croft 2007) and grammatical classes (Croft 2001, Tomasello 2003) are emergent." See also Mielke (2008: 100–101): "In most innate distinctive feature theories (e.g. Chomsky and Halle 1968), the features are universal cognitive entities specified in Universal Grammar which are directly related to their phonetic correlates, and which are the building blocks of phonological patterns. In emergent feature theory, features exist only as needed by a given language, but, as in innate feature theories, they correspond to phonological patterns."

³⁵ This does not indicate, however, that these emergent properties are restricted to that language alone. As the focus of this paper is on sonority, I leave open the discussion of which other phonological properties are emergent, and which may be innate.

Funding Information

This study was funded in part by the Deutscher Akademischer Austausch Dienst (DAAD), Max Kade Foundation, and the Louise McNutt Fellowship and Salaroglio Modern Foreign Language Scholarship (College of Arts and Sciences, Indiana University).

Competing Interests

The author has no competing interests to declare.

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How to cite this article: Noelliste, Erin. 2019. Bavarian German *r*-Flapping: Evidence for a dialect-specific sonority hierarchy. *Glossa: a journal of general linguistics* 4(1): 79.1–26. DOI: <https://doi.org/10.5334/gjgl.789>

Submitted: 26 August 2018 **Accepted:** 23 April 2019 **Published:** 12 July 2019

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