Inward and outward allomorph selection: An overview

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Word count: 11,304

ABSTRACT

This chapter provides an overview of directionality relations in allomorphy selection. One type is 'inward-conditioning', where the trigger is in a structurally outer position compared to the target of allomorphy (i.e. it is further away from the lexical head of the construction). This type can also be referred to as 'outward-sensitivity'. Its counterpart is 'outward-conditioning', where it is the trigger which is in an inner position and the target in an outer position (it can also be referred to as 'inward-sensitivity'). A number of typologically diverse cases are presented to illustrate directional asymmetries in allomorphy selection. One robust generalization involves 'grammatically-conditioned allomorphy', in which the trigger is a morphosyntactic feature (e.g. [PLURAL]), feature bundle (e.g. [3.SG.FEM]), or category (e.g. [TENSE]). In this type of allomorphy, both inward-conditioning and outward-conditioning are widespread, showing a clear directional symmetry. In contrast, other types of allomorphy such as 'lexically-conditioned' (the trigger is a particular lexical root), 'morphologically-conditioned' (a purely morphological feature, e.g. conjugation class), and 'phonologically-conditioned allomorphy' show a clear directional asymmetry. Here, allomorph selection almost always involves outward-conditioning, i.e. the trigger is in an inner position. Cases of inward-conditioning are rare and controversial. Taken all together, the propensity for triggers to be inward compared to targets is called the 'directional asymmetry in allomorphy selection'.

Keywords: allomorphy, directionality, suppletion, cyclic exponence, typology, morphological theory

1 Introduction

The focus of this chapter is the intersection of allomorph selection and inward/outward directionality. Let us first establish working definitions, embedded within a realizational morphological model in which morphosyntactic features and feature bundles are mapped to an exponent composed of phonological material, e.g. [DEFINITE] ↔ [ðə] for English *the* (e.g. Halle & Marantz 1993, Embick 2015, Scheer 2020, *inter alia*). '**Allomorphy**' is defined as a single feature or feature bundle [F] mapped to more than one exponent $\phi_1 \ldots \phi_n$, whose distribution depends on some aspect of the context (e.g. *a* and *an* for [INDEFINITE] in English). I repeat the schematic representation of allomorphy in (1) from Bonet & Harbour (2012).

(1)	[F]	↔	ϕ_1	/	Context$_1$	
			ϕ_2	/	Content$_2$	…

In this chapter, it is the relationship between '[F]↔ϕ' and 'Context' that is examined.

For our purposes, I only examine cases where the allomorphs $\phi_1 \ldots \phi_n$ constitute separately stored entries in a morphological lexicon, which are in complementary distribution based on the presence or absence of the relevant context. In this way, 'allomorphy' here is synonymous with 'suppletive allomorphy', and no distinction is made between different types of suppletion (e.g. strong vs. weak). Our definition rules out cases interpreted as purely syntactic (e.g. syntactic agreement – Weisser 2019), as well as those cases where the allomorphs can be reduced to a single underlying representation derivable by general and independently needed phonological rules, e.g. English past [d]~[t]~[əd] (Kiparsky 1996, Paster 2006, 2016). The criteria that are adopted to distinguish (suppletive) allomorphy from other morphophonological phenomena are in (2), drawn from many sources.[1]

(2) Criteria to distinguish (suppletive) allomorphy

a. Phonological distance of forms: two allomorphic forms are suppletive if they exhibit phonological distance past a baseline threshold, measured in phonological structure (e.g. shared segments or features)

b. Uniqueness of alternation: two allomorphic forms are suppletive if the alternation is not found in comparable morphophonological contexts

c. Phonological naturalness of alternation: two allomorphic forms are suppletive if their alternation cannot be derived via a phonologically natural rule (e.g. with respect to phonological locality, typological precedence, *etc*.)[2]

In what follows, the context which co-varies with a particular allomorph will be called the '**trigger**', the underlying morphosyntactic features [F] called the '**target**', and the insertion of one allomorph over another called '**selection**'. The stated purpose of this paper is explicate issues of '**directionality**' between the trigger and target of allomorphy. In other words, what kinds of allomorphy are possible when the trigger is located in an outer position and the target an inner one, and vice versa?

To sustain a coherent notion of directionality, I assume hierarchical structure both within words and between words, e.g. *meaninglessness* is rendered hierarchically as [[[[mean]-ing]-less]-ness] and *a big old dog* as [a [big [old [dog]]]]. In this chapter, I do not assume ontologically distinct hierarchical structures within versus between words; regardless of assumptions, directionality can be assessed in any hierarchical model. Notions of 'inner' and 'outer' only make sense relative to some reference point. I refer to this reference point as the '**nucleus**'. In what follows, I assume the nucleus to always be the lexical root (~semantic head), e.g. the verb *mean* and the noun *dog* above.

Now we can define our primary directionality dichotomy. If the trigger is in an outer position compared to a target, then it is **'inward-conditioning'**. This is also referred to as **'outward-sensitivity'** from the perspective of the target rather than the trigger (Carstairs-McCarthy 2001:225). These are simply notational variants. In contrast, if the trigger is in an inner position compared to a target, this is called **'outward-conditioning**' (or '**inward-sensitivity**'). This is schematized in (3) in a toy hierarchical structure, where the trigger of allomorphy is underlined and the target is in bold (this convention for denoting triggers vs. targets is followed throughout).

(3) Directionality relations between the target and trigger of allomorphy

a. Inward-conditioning (= outward-sensitivity)

[[[◌] **●**] ⟵ ○]
Nucl **Targ** Trig

b. Outward-conditioning (= inward-sensitivity)

[[[◌] ○] ⟶ **●**]
Nucl Trig **Targ**

In cases where the head root is the target (Nucl=**Targ**) or the trigger (Nucl=Trig), this automatically qualifies as inward- and outward-conditioning, respectively.

The rest of this paper is organized as follows. Section 2 provides an overview of directionality relations when the trigger of allomorphy is morphosyntactic, e.g. lexical roots, syntactic features/structure, and morphological features such as conjugation class membership. Section 3 provides an overview of directionality with phonological triggers, e.g. a segment, segmental feature, tone, stress, prosodic structure, *i.a*. Section 4 summarizes the typology and situates it within the theoretical literature. Section 5 provides a conclusion.

2 Directionality and morphosyntactic triggers

This section examines **morphosyntactic allomorphy**. This section is split into four types: lexically-conditioned, grammatically-conditioned, morphologically-conditioned, and syntactically-conditioned.

2.1 Lexically-conditioned

A pervasive type of allomorphy involves a trigger constituting one or more lexical roots, referred to as **lexically-conditioned allomorphy**. Examples of this type are ubiquitous, with the great majority of languages displaying at least some allomorphy along these lines. Commonly cited examples from English are plural *-en* in *oxen* or the plural Ø in *sheep*, *deer*, etc., rather than default *-s* (Bonet & Harbour 2012).

(4)	[PL]	↔	-en	/	{√OX, …}	___
			Ø	/	{√SHEEP, √DEER, …}	___
			-s			

In these structures, the trigger and the nucleus are the same (the lexical root), entailing that this is outward-conditioning (i.e. inward-sensitivity).

Is inward-conditioning (outward-sensitivity) possible with lexically-conditioned allomorphy? Logically speaking this would seem not to be possible, as the lexical root is the nucleus by definition. However, one potential type of lexically-conditioned allomorphy with inward-conditioning involves compounds, where a lexical item is not necessarily the head of the construction. An example from Dutch compounds is in (5), from Fenger & Harðarson (2018). Here, the modifying noun N_1 and modified head noun N_2 are 'linked' by an intervening linker morpheme (Dutch compounds are always right-headed). This linker has two shapes, *-en* (a.) or *-s* (b.-c.).[3]

(5) Dutch linker allomorphy in compound structure [modifying N_1]-LINK-[head N_2]

a.	katt-**en**-luik	cat-**LINK**-shutter	'cat flap'	cf. katt-en	cat-PL
b.	varken-**s**-voer	pig-**LINK**-food	'pig food'	cf. varken-s	pig-PL
c.	dorp-**s**-plein	village-**LINK**-square	'village square'	cf. dorp-en	village-PL
d.	(Note non-existent pair: * N_1-**en**-N_2 corresponding to N_1-s N_1-PL)				

While the lexical identities of both N_1 and N_2 contribute to the selection of the allomorph, the identity of N_1 appears to be the prime determiner, which also affects plural allomorph selection. For example, example (a.) shows that the linker *-en* is used if N_1's plural is formed with *-en*. Example (d.) states that if N_1's plural is formed with *-s*, its linker must be *-s* as well. Moreover, lexical statistics and experimental work in Krott *et al*. (2002) show that while both sides of the linker matter, the "strongest analogical factor predicting linkers appears to be the bias of the Left Constituent Family", i.e. N_1.

If we assume that N_2 is the head, and that the linear order of morphemes reflects a hierarchical order [N_1-[LINK-[N_2]]], then the linker (the target) is inward and the N_1 (the trigger) is outward, meeting the definition of inward-conditioning (outward-sensitivity). One should note, however, that such a structure is not universally accepted. Fenger & Harðarson specifically analyze the linker here as a realization of a type of nominal categorizing head *n* which is sister to the first noun root, i.e. [[$\sqrt{}_1$]-*n*…]. Under their representation, Dutch linker allomorphy constitutes outward-conditioning since the target (the linker *n*) is structurally higher than its trigger ($\sqrt{}_1$). I leave unresolved how Fenger & Harðarson's analysis squares with Krott *et al*.'s observations that even the head N_2 has a small but significant role in the shape of the linker, and whether this consequently retains this example's status as involving inward-conditioning from an outer lexical root.

2.2 Grammatically-conditioned

Another salient type of allomorphy is **grammatically-conditioned allomorphy**, where the trigger is a (non-lexical) morphosyntactic feature, feature set, or category. In this type, the lexical root is often the target of allomorphy, typically referred to as **root suppletion**. One common example from English is *go*/*went* conditioned by tense, but virtually all languages consist of some type of root suppletion. In verbs, this is often conditioned by number (singular/plural) or tense/aspect/mood, but also categories such as plurality, polarity/negation, and even honorifics. Examples of number-based verb root suppletion in Hiaki [yaq] is shown in Table 1 (from Harley 2014).

	Singular	Translation	Plural	Translation
a.	vuite	'run.SG'	tenne	'run.PL'
b.	siika	'go.SG'	saka	'go.PL'
c.	weama	'wander.SG'	rehte	'wander.PL'
d.	kivake	'enter.SG'	kiime	'enter.PL'
e.	vo'e	'lie.SG'	to'e	'lie.PL'
f.	weye	'walk.SG'	kaate	'walk.PL'
g.	mea	'kill.SGOBJ'	sua	'kill.PLOBJ'

Table 1: Hiaki number-based verb root suppletion (Harley 2014: 234)

For nouns, common triggers are number, case, gender, person, and possession. See Brown *et al.*'s (2003) 'Surrey Suppletion Database', among other sources.

In root suppletion, the nucleus itself is targeted and the trigger is some outwardly-located morphosyntactic material, thus constituting inward-conditioning. While some morphological proposals refute root suppletion on theoretical grounds[4], the general consensus is that it is simply too rich an empirical phenomenon to explain away. As Choi & Harley (2019) demonstrate, idioms are useful for diagnosing and substantiating root suppletion, e.g. compare suppletive English pairs *go bananas* and *went bananas* which preserve the idiomatic meaning 'act crazy', to non-idiomatic **move bananas*. Choi & Harley use this same logic to argue that honorific suppletion in Korean equally preserves idiomatic meaning, demonstrated with suppletive verbs that have special forms in honorific contexts (technically, in the context of a Hon⁰ morpheme).

(6)	[√EAT] ↔	capswusi- mek-	/	[___ … Hon⁰]

(7)	Korean idiomatic readings preserved under suppletion			(Choi & Harley 2019:1343)	
	kkamakwi	koki-lul	mek/capswusi-ta		
	crow	meat-ACC	eat/eat.HON-DECL	'to forget'	(lit. 'eat crow meat')

We can safely consider root suppletion (entailing inward-conditioning) as both possible and ubiquitous, and focus the rest of this subsection on directionality with non-lexical exponents.

Our starting point is a distinction between categories and features (Carstairs 1987, Matthews 1991, Carstairs-McCarthy 2001). **Morphosyntactic categories** refer to higher-order taxonomic labels like 'Case' for nouns or 'Tense' for verbs, while **morphosyntactic features** refer to the paradigmatic contrasts within the category, e.g. nominative/accusative/dative, past/present/future, and so on. Let us examine categories vs. features with respect to directionality, beginning with inward-conditioning (outward-sensitivity). Carstairs-McCarthy (2001) presents an example of category-based conditioning from

Hungarian plural allomorphy (Table 2). In row a., the singular form of the noun is bare while the plural is marked by the plural suffix -*k* (plus the theme vowel -*o*-). The singular column demonstrates the forms with various possessor features, realized as a final suffix (plus a preceding theme vowel). Of importance here is the plural column, which shows that the plural suffix is -*i* (with theme vowel -*a*-) in the context of all possessive suffixes, rather than default -*k* (with theme -*o*-).

	Singular		Translation	Plural		Translation
a.	dal	song	'song'	dal-o-**k**	song-TH-**PL**	'songs'
b.	dal-o-m	song-TH-1SG	'my song'	dal-a-**i**-m	song-TH-**PL**-1SG	'my songs'
	dal-o-d	song-TH-2SG	'your song'	dal-a-**i**-d	song-TH-**PL**-2SG	'your songs'
	dal-a-Ø	song-TH-3SG	'his/her song'	dal-a-**i**-Ø	song-TH-**PL**-3SG	'his/her songs'
	dal-u-nk	song-TH-1PL	'our song'	dal-a-**i**-nk	song-TH-**PL**-1PL	'our songs'
	dal-o-tok	song-TH-2PL	'your song'	dal-a-**i**-tok	song-TH-**PL**-2PL	'your songs'
	dal-u-k	song-TH-3PL	'their song'	dal-a-**i**-k	song-TH-**PL**-3PL	'their songs'

Table 2: Hungarian inward-conditioning by an entire morphosyntactic category (allomorphy in bold)

This allomorphy is triggered by the morphosyntactic possessor category [POSS], as it manifests across all individual possessor features. It constitutes inward-conditioning (outward-sensitivity) because [POSS] (the trigger) is more outward than [PL] (the target) with respect to noun (the nucleus).

(8) [PL] ↔ -i / ___ [POSS]
-k

Although Carstairs-McCarthy's point in discussing Hungarian is to argue that only morphosyntactic categories can be inward-conditioning, several cases have been identified which are conditioned by a morphosyntactic feature, not an entire category. One case is from Georgian, where an (inner) applicative is realized as *u*- in the context of (outer) third person (i.e. [-PARTICIPANT]), but as *i*- otherwise (Bonet & Harbour 2012:228-229, citing Hewitt 1995). Here, the allomorphy is specifically conditioned by one value and one value only of the category Person.

(9) Georgian *i*-/*u*- applicative allomorphy conditioned by an outer morphosyntactic feature
a. mo-m-**i**-rbina 'I had run here'
b. mo-gv-**i**-rbina 'we had run here'
c. mo-g-**i**-rbina(t) 'you(.PL) had run here'
d. mo-Ø-**u**-rbina(t) '(s)he/they had run here'

(10) [APPL] ↔ u- / [φ:-PART] ___
i-

Several other cases could be mentioned, e.g. in Itelmen [itl] (Bobaljik 2000:9), where an (inner) class morpheme [CL:II] is realized as one of several shapes {-k-,-čiŋ-,čɣʷi-,-ik,-xk-,-ki-} depending on the subject and object agreement features (in an outer location). The trigger of each allomorph is not a category, but rather one or more features of the category.

More contentious is outward-conditioning (inward-sensitivity) with grammatically-conditioned allomorphy, of either the category or feature type. Although there exist certain maximally-restrictive models which exclude this type – e.g. Bobaljik (2000) and other syntactically-oriented morphology theories – enough cases have been identified that it should be considered empirically attested. One well-known case also discussed in Carstairs-McCarthy (2001) is Latin agreement conditioned by the perfect (11)-(12). The normal exponent for second person singular agreement is -*s* (a.). When adjacent to the perfect morph -*v(e)*, a special form -*istī* is used instead (b.). As many works have emphasized, this allomorphy requires adjacency: when the perfect morph is separated from agreement, the default allomorph -*s* is used once again (c.). Regardless, this constitutes outward-conditioning.

(11) Latin allomorphy with outward-conditioning from feature [PERFECT]

a.	Present indicative	amā-**s**	'you love'
b.	Perfect indicative	amā-v-**istī**	'you loved'
c.	Pluperfect indicative	amā-ve-rā-**s**	'you had loved'

(12) [φ:2SG] ↔ -istī / [PERF] ___
-(i)s

Additional examples of such outward-conditioning (inward-sensitivity) include the following:

(13) Outward-conditioning by a morphosyntactic feature
   a. Bulgarian (Gribanova & Harizanov 2017) – inner gender and number features condition form of outer [DEFINITE] suffix
   b. Moro [mor] (Jenks & Sande 2017) – inner feature [PROPER] (on names and kinship terms) conditions overt exponence of outer [ACCUSATIVE] case
   c. Modern Standard Arabic (Winchester 2017) – an inner gender feature [-FEM] conditions a form of an outer number feature [+AUGMENTED]
   d. Bengali (Banerjee 2020) – inner feature [PERFECT] conditions form of outer [NEGATIVE]

The examples in (13) constitute outward-conditioning from a morphosyntactic feature. While it appears to be rarer, one example demonstrating conditioning from a morphosyntactic category comes from Thalanyji [dhl] (Austin 1981), shown in Table 3. Like many related Australian languages, Thalanyji shows extensive case-marking allomorphy. Following Austin, we can split this allomorphy into three groups: case marking on nouns (a.), on pronouns (b.), and on demonstratives (c.). Simplifying slightly for our purposes, individual case markers on nouns (a.) either have only one shape or exhibit allomorphy sensitive to number of syllables in the stem. In contrast, with pronouns (b.) and demonstratives (c.), individual case markers have a single shape for the entire category regardless of syllable count. Note that in this table, irregular forms are italicized.

		NOM	ERG	ACC	DAT	LOC
a.	Noun	$[\ ]_N$	$[\sigma\sigma]_N$-**nggu** $[else]_N$-**lu**	$[\ ]_N$-**nha**	$[\ ]_N$-**gu**	$[\sigma\sigma]_N$-**ngga** $[else]_N$-**la**
b.	1SG	ngatha	-	ngatha-**nha**	*jurdi*	ngatha-**la**
	1DU.IN	ngali	ngali-**lu**	ngali-**nha**	ngali-**ma**	ngali-**la**
	1DU.EX	ngaliya	ngaliya-**lu**	ngaliya-**nha**	ngaliya-**ma**	ngaliya-**la**
	1PL.IN	nganhurru	nganhurru-**lu**	nganhurru-**nha**	nganhurru-**ma**	nganhurru-**la**
	1PL.EX	nganarna	nganarna-**lu**	nganarna-**nha**	nganarna-**ma**	nganarna-**la**
	2SG	nyinda	nyinda-**lu**	nyinda-**nha**	nyinda-**ma**	nyinda-**la**
	2DU	nhubalu	nhubalu-**lu**	nhubalu-**nha**	nhubalu-**ma**	nhubalu-**la**
	2PL	nhurra	nhurra-**lu**	nhurra-**nha**	nhurra-**ma**	nhurra-**la**
	3SG	bala	bala-**lu** (~*balu*)	bala-**nha**	bala-**ma**	-
	3DU	bula	bula-**lu**	bula-**nha**	bula-**ma**	-
c.	PROX	*nhaa*	yu-**lu**	yi-**nha-nha**	yu-**rnu**	yu-**la**
	DIST	*ngunha*	ngu-**lu**	ngu-**nha-nha**	ngu-**rnu**	ngu-**la**

Table 3: Thalanyji case allomorphy (Deak & the Wangka Maya Pilbara Aboriginal Language Centre 2008:35, after Austin 1981:216)[5]

Of importance are the forms of the dative case. This case [DAT] is realized as *-gu* with all nouns, as *-ma* with all pronouns, and *-rnu* with the two demonstratives. Because [DAT] (the target) is in an outer position, this constitutes outward-conditioning.

(14)	[DAT]	↔	-ma	/	[PRON] ___
			-rnu	/	[DEM] ___
			-gu		

With the exception of the portmanteau *jurdi* [1SG.DAT], this is consistent across the relevant category. These data thus fill out the logically possible combinations: grammatically-conditioned allomorphy can show both inward- and outward-conditioning, at both the feature and category level.[6]

2.3 Morphologically-conditioned

Next, let us consider **morphologically-conditioned allomorphy**, where the trigger is purely morphological (i.e. not a natural class morphosyntactically, semantically, or phonologically). Unlike with grammatically-conditioned allomorphy, the trigger (set) cannot be reduced to a morphosyntactic feature like [POSS] or [DEM] as above, but instead is *prima facie* analyzed as being idiosyncratically marked with a morphological diacritic.

Morphological designations such as conjugation or declension cases are often defined based on their morphologically-conditioned allomorphy. In many Pama-Nyungan Australian languages, verb roots are classified based on the form of a tense/aspect/mood (TAM) allomorph they select, often conventionalized based on common phonological characteristics of the conditioned allomorphs. For example, Yindjibarndi [yij] has four verb root classes (Wordick 1982:79ff): the Ø-class, L-class, R-class and N-class. These four classes are shown in (15), along with the allomorph of the past tense they select. The numbers at the right refer to the page in Wordick.

(15) Yindjibarndi morphological classes dividing verb roots

a.	ngarrku-	eat$_{Ø}$	ngarrku-**nha**	eat$_{Ø}$-**PAST.Ø**	(44)
b.	payha-	throw$_{L}$	payha-**rna**	throw$_{L}$-**PAST.L**	(63)
c.	wanpi-	beat$_{R}$	wanpi-**rna**	beat$_{R}$-**PAST.R**	(66)
d.	thuwayi-	spear$_{N}$	thuwayi-**na**	spear$_{N}$-**PAST.N**	(171)

In these examples, L-class and R-class roots selected the same past tense marker *-rna* (IPA: /-ɳa/), though other allomorphy clearly distinguish these classes. Table 4 shows a range of class-conditioned TAM allomorphy. This shows syncretism between the L- and R-class as above (row a.), but also syncretism between the L- and N-class (b.) and even the L-, R-, and N- class all together (c.). The forms in this table are presented in IPA, with their orthographic forms italicized in parentheses.

		Ø-class		L-class		R-class		N-class	
a.	PAST	-n̪a	(*-nha*)	-ɳa	(*-rna*)	-ɳa	(*-rna*)	-na	
	IMPERFECTIVE	-ŋu	(*-ngu*)	-ɳu	(*-rnu*)	-ɳu	(*-rnu*)	-nu	
b.	IMPERATIVE	-ma		-nma		-ɳma	(*-rnma*)	-nma	
c.	PRESENT	Ø		-ku		-ku		-ku	
	OPTATIVE	-ja:	(*-yaa*)	-ca:	(*-tyaa*)	-ca:	(*-tyaa*)	-ca:	(*-tyaa*)

Table 4: Yindjibarndi TAM allomorphy based on morphological class (Wordick 1982:98)

Although there are gradient correlations between class membership and phonological and transitivity properties of roots (related to the diachronic sources of these classes), class membership overall is not predictable synchronically (p. 81).

In Yindjibarndi, the root is the trigger, making this outward-conditioning. Let us further examine the intersection of morphologically-conditioned allomorphy and directionality, following discussion in Inkelas (2017) on the Peruvian language Nanti [cox] (Michael 2008). In Nanti, verb roots are idiosyncratically classified into two classes – an I-class and an A-class – based on the allomorphy they trigger with realis/irrealis suffixes (16).

		REALIS	IRREALIS
(16)	Nanti allomorphy	REALIS	IRREALIS
a.	I-class trigger:	-i	(N-)…-e
b.	A-class trigger:	-a	(N-)…-eNpa

Example (17) contrasts an I-class root *ha* 'go' (a.-c.) with an A-class root *shiNki* 'be drunk' (d.-f.). The corresponding page numbers from Michael (2008) are to the right.

(17) Nanti allomorphy (in bold) with their triggers (underlined)

a.	i=<u>ha</u>-**i**		haNta …	[ihat**i** hanta…]	
	3MS=<u>go$_{I}$</u>-**REAL.I**		there	'he goes there…'	(370)
b.	i=<u>ha</u>-ak-**i**		paNko-tsi-ku	[ihatak**e** pankotsiku]	
	3MS=<u>go$_{I}$</u>-PFTV-**REAL.I**		house-NPOSS-LOC	'he went to the house'	(303)
c.	ha	o=agabeh-i	o-<u>ha</u>-**e**	[ha agabehi ohat**e**]	
	NEG	3NMS=be.able-IRR$_{I}$	3NMS=<u>go$_{I}$</u>-**IRR.I**	'she shouldn't go'	(436)
d.	…	o-Nti	pi=<u>shiNki</u>-**a**=ra	[…pishinkit**a**ra]	
		3NMS-COP	2S=<u>be.drunk$_{A}$</u>-**REAL.A**=DEP	'…you were intoxicated'	(168)
e.	…	i=<u>shiNki</u>-ak-**a**		[…ishinkitak**a**]	
		3MS=<u>be.drunk$_{A}$</u>-PFTV-**REAL.A**		'He was drunk'	(282)
f.	…	i=N-<u>shiNki</u>-**eNpa**=ra		[…ishinkit**enpa**ra]	
		3MS=IRREAL-<u>be.drunk$_{A}$</u>-**IRR.A**=SUB		'…when he is drunk'	(429)

The root triggers the special form of the realis/irrealis suffix even if it is non-local due to an intervening suffix, e.g. the perfective suffix *–ak* PFTV in b. and e. Synchronically, class membership for roots is not predictable.

While most affixes do not affect class membership (they are neutral, like *–ak*), a small minority of suffixes idiosyncratically change class membership. These are listed in (18). To demonstrate the idiosyncrasy of the triggering suffixes, each is compared to a neutral suffix which is comparable in morphological position, phonological shape, and effect on argument structure (e.g. valency changes).

(18) Nanti class-changing suffixes

			Cf.		
a.	A-class triggering suffixes		Cf.	Neutral	
	-be	FRUSTRATIVE$_{A}$		-reh	REVERSATIVE
	-ant	INSTRUMENTAL$_{A}$		-ako	INDIRECTIVE.APPLICATIVE
b.	I-class triggering suffixes				
	-ah	REGRESSIVE$_{I}$		-ut	RETURNATIVE
	-apah	ADLATIVE$_{I}$		-an	ABLATIVE

These class-changing suffixes are illustrated in (19). The verb *neh* 'see' normally triggers the I-class form (a.), but when the class-changing suffix *-be* FRUSTRATIVE$_{A}$ intervenes, it is the suffix which triggers the A-class form (b.). Parallel patterns are seen in (20) with *-ah* REGRESSIVE$_{I}$ which triggers I-class forms, overriding the root class.

(19) Nanti A-class suffix

a.	no=neh-ak-**i**=ri	[nonehak**e**ri]	
	1S=see$_{\text{I}}$-PFTV-**REAL.I**=3MO	'I saw him'	(355)
b.	no=neh-be-ak-**a**=ri	[nonehabetak**a**ri]	
	1S=see$_{\text{I}}$-FRUS$_{\text{A}}$-PFTV-**REAL.A**=3MO	'I saw him (but without the expected result)'	(251)

(20) Nanti I-class suffix

a.	no=pig-ak-**a**	[nopigak**a**]	
	1S=return$_{\text{A}}$-PFTV-**REAL.A**	'I returned'	(257)
b.	no=pig-ah-**i**	[nopigah**i**]	
	1S=return$_{\text{A}}$-REG$_{\text{I}}$-**REAL.I**	'I returned'	(258)

For these data, Inkelas (2017) analyzes the triggering class features as 'L-features', essentially diacritics which are syntactically and semantically arbitrary and therefore a purely morphological classification. The morphologically-conditioned allomorphy here show outward-conditioning (inward-sensitivity) with both roots and affixes: an L-feature of an inner affix is the trigger and an outer affix which is the target. Other languages showing outward-conditioning from morphological classes include Nimboran [nir] classes I/II/III (also discussed in Inkelas 2017, citing Anceaux 1965 and Inkelas 1993) and Nez Perce [nez] C-/S-classes (Aoki 1970, Deal & Wolf 2017). It is important to keep in mind, however, that any analysis as allomorphy in such cases should be accepted only if more-grounded explanations have been tried and discarded first. Fine phonological and syntactic analyses are always required as a baseline.

Is the inverse also possible, i.e. inward-conditioning with morphologically-conditioned allomorphy? Relevant to this question is the (controversial) concept of the '**morphome**' (Aronoff 1994, 2012, Luís & Bermúdez-Otero 2016), where there is a systematic mapping of an unnatural group of meanings to a unified set of forms (see O'Neill 2014:31 for several competing definitions). At least some purported morphomic patterns show inward-conditioning. We can illustrate this with an oft-cited morphomic pattern, the Latin so-called 'third stem' (Aronoff 1994). Roots in Latin have distinct shapes depending on the morphological context, e.g. the form of the stem in the infinitive (*caed*- 'cut' below) systematically differs from that of its third stem form *caes*- which shows up in certain morphological contexts, e.g. participles in (21).

(21) Latin third stem (Bermúdez-Otero & Luís 2016)

caedere	→	**caes**-us	
'to cut'		**cut.III**-PARTICIPLE	(cf. other stems *caedō*, *cecīdī*, etc.)

This qualifies as morphomic because (i) the group of morphological constructions which require the third stem – the supine (***caes**-um*), eventive, instrumental, agentive nouns (***caes**-or*), desiderative, intensive, and frequentative verbs (***caes**-itō*), adjectives and adverbs (***caes**-im*) – do not form a semantically or syntactically natural class, and (ii) this class triggers the third stem of roots across the lexicon systematically. In other words, this is not just idiosyncratic to the root √CUT, but also appears with √EAT (*edere* vs. III participle *ēsus*), √WIN (*vincere* vs. III participle *victus*), √CARRY (*ferre* vs. III participle *lātus*), *inter alia*.

One way to formulate this as a realizational rule is in (22), which states that the root is realized as *caes*- in the context of morphs (or morphological constructions) which are indexed as triggering the third stem, notated simply as M$_{\text{III}}$.

(22)

[√CUT] ↔	caes-	/	___ M$_{\text{III}}$	(where M$_{\text{III}}$=participle, supine, adj, adv,…)
	caed-	…		

There are several other ways to conceptualize this, but the directionality relation is clear: if the trigger of the stem form is understood as a diacritic feature on an outer suffix, this meets the definition of inward-conditioning (outward-sensitivity).

Do morphomic patterns show full directional symmetry? Currently, this is difficult to address due to the morphome being notoriously difficult to define and, as alluded to above, its very existence is quite contentious (see the state-of-the-art summary in Bermúdez-Otero & Luís 2016). Moreover, for both morphomic patterns (e.g. Latin) and conjugation classes (e.g. Yindjibarndi and Nanti), cases of morphologically-conditioned allomorphy are under-theorized and under-documented, with numerous competing analyzes (e.g. for Latin, see Steriade 2016 who identifies several important phonological and semantic generalizations undercutting the morphomic analysis). This undermines making any firm conclusions regarding directionality asymmetries.

2.4 Syntactically-conditioned

The fourth type is **syntactically-conditioned allomorphy**, where the underlying syntactic structure acts as (part of) the trigger for allomorphy. Unlike with grammatically-conditioned allomorphy in §2.2, here it is not sufficient to refer solely to a morphosyntactic feature or feature bundle. Syntactic relations (e.g. sisterhood) must also be appealed to.

I illustrate this type from Danish allomorphy with the definite marker (DEF) (Hankamer & Mikkelsen 2018; see references therein). The allomorphy generally works as follows: when DEF appears with a noun alone, it is realized as a suffix *-en*, but if there is a modifier intervening between DEF and a noun, DEF is realized as an initial particle *den*.[7]

(23) Danish DEF allomorphy (Hankamer & Mikkelsen 2018)

a.	*kant-**en***			(cf. ***den** kant*)
	edge-**DEF**			'the edge'
b.	***den***	*skarpe*	*kant*	(cf. **skarpe kant-**en***)
	DEF	sharp	edge	'the sharp edge'

In their account, Hankamer & Mikkelsen propose a 'sisterhood condition' which states that [DEF] is realized as the suffix *-en* "only if it is a sister to a minimal N" in the syntax (*den* being the default). A realizational rule is in (24) below, slightly modified form the original.

(24) [DEF] ↔ -en / $[\ \_\_\ N^{o}\ ]_{DP}$
den

If there is an intervening adjective (b. above), this disrupts the sisterhood condition and default *den* is then inserted.

Importantly, the underlying syntactic structure plays a role in allomorph selection, and not simply linear proximity to particular morphosyntactic features. A minimal pair from Hankamer & Mikkelsen involving relative clauses illustrates this fact, in (25) below. Example (a.) shows a restrictive relative clause whose underlying (and independent motivated) syntax is $[\ D^{o}\ [\ CP\ ]\ ]_{DP}$. In this case, the head N remains within the relative clause and therefore DEF is not sister to it, despite their surface adjacency; *den* is realized by default, as expected. In contrast in (b.) with an adjunct-like non-restrictive clause, DEF is sister to the noun (i.e. $[\ D^{o}\ N^{o}\ ]_{DP}$) and therefore the suffix *–en* is selected.

(25) Danish DEF allomorphy sensitive to syntactic structure

a. [D^{o} [CP]]$_{DP}$

[**den**	[stol	som	jeg	sad	på]]
DEF	chair	that	I	sat	on

'the chair that I sat on' (restrictive)

b. [[D^{o} N^{o}]$_{DP}$ [CP]]$_{DP}$

[[stol-**en**]	[som	jeg	sad	på]]
chair-**DEF**	that	I	sat	on

'the chair, which I sat on' (non-restrictive)

[Cf. %'the chair that I sat on' (restrictive)][8]

For the Danish data, the target (DEF) is outer compared to the trigger (N^{o}), therefore constituting outward-conditioning (inward-sensitivity). Data from Russian shows that we also find the opposite directionality as well. Russian has two sets of third-person pronouns (Timberlake 2004:117, *i.a.*): an *n*-initial pronoun which is inserted after prepositions and one inserted by default, e.g. the forms of the 3SG.F DATIVE pronoun 'to her' in (26).

(26) [PRON:3SG.F][DAT] ↔ nej / [P^{o} __]$_{PP}$
jej

Here, the trigger P^{o} is outer and the target inner, therefore constituting inward-conditioning (outward sensitivity).

One should note, however, that because syntactically-conditioned allomorphy by definition involves a syntactic structure trigger, there are several alternatives that can be posited which would invalidate an allomorphy analysis. For example, if we assume that prepositions assign a [P-CASE] feature (following Philippova 2018:45), then the two exponents *nej* and *jej* actually realize distinct morphosyntactic feature bundles and no longer meet our definition of allomorphy. This issue generally complicates all interpretations of syntactically-conditioned allomorphy and undermines properly assessing directionality relations.

3 Directionality and phonological triggers

Selection of a (suppletive) allomorph can also be conditioned by phonological properties, the focus of this section. Two types are discussed: segmentally-conditioned allomorphy and suprasegmentally-conditioned allomorphy. As established in §1, I do *not* include cases where the allomorphs can be reduced to a single underlying representation derivable by a general phonological rule, e.g. English PAST [d]~[t]~[əd], reducible to /-d/.

3.1 Segmentally-conditioned

Segmentally-conditioned allomorphy involves a trigger which is either (i) a segment or natural class of segments (e.g. a vowel), or (ii) a segmental feature or natural class of segmental features (e.g. [LABIAL]). A commonly cited example is 3SG.M allomorphy in Moroccan Arabic [ary], realized as *-h* after vowels but *-u* after consonants (Mascaró 2007, citing Harrell 1962).

(27) Moroccan Arabic 3SG.M clitic phonologically-conditioned allomorphy

	a.		b.	
	xtˤa-**h**	'his error'	ktab-**u**	'his book'
	ʃafu-**h**	'they saw him'	ʃaf-**u**	'he saw him'
	mʕa-**h**	'with him'	menn-**u**	'from him'

The distribution appears non-trivial: both avoid adjacent vowels/consonants, which would constitute more marked patterns (i.e. *[xtˤa-u] and *[ktab-h]).

Segmentally-conditioned allomorphy where the conditioning environment is a vowel (V) vs. a consonant (C) is extremely common cross-linguistically. Paster (2006) highlights numerous cases of this type, which include Yidiny [yii] locative/instrumental/allative case (Dixon 1977), the Korean conjunctive suffix (Lee 1989, Lapointe 1999), Russian active participles (Timberlake 2004), Haitian Creole definite markers (Hall 1953, Klein 2003), among many others.

Further, segmentally-conditioned allomorphy may involve a natural class of segments defined by a phonological feature (or feature set). Another well-known case discussed in Paster (2006) is the Tahitian causative/factitive, which is exponed as the prefix *ha'a-* when the root begins with a labial sound but and *fa'a-* elsewhere (citing Lazard & Peltzer 2000:224-225; cf. Scheer 2016 for a phonological alternative without stored allomorphy). Here, the segments /m f v/ form a natural class, sharing the feature [LABIAL].

(28) Tahitian phonologically-conditioned allomorphy triggered by feature [LABIAL]

a.	mana'o	'think'	('penser')	**ha'a**-<u>m</u>ana'o	'remember'	('se rappeler')
	fiu	'grow tired'	('se lasser')	**ha'a**-<u>f</u>iu	'be bored'	('ennuyer, s'ennuyer')
	veve	'be poor'	('pauvre')	**ha'a**-<u>v</u>eve	'impoverish'	('appauvrir')
b.	'amu	'eat'	('manger')	**fa'a**-'amu	'make eat'	('faire manger, nourrir')
	rave	'do, make'	('faire')	**fa'a**-rave	'make do'	('faire faire')
	tai'o	'read'	('lire')	**fa'a**-tai'o	'make read'	('faire lire')

These examples illustrate a robust property of phonologically-conditioned allomorphy: the trigger is inward and the target outward, thus constituting outward-conditioning (inward-sensitivity). This constitutes the clearest directional asymmetry in allomorphy selection: a phonological trigger is virtually always outward-conditioning (Paster 2006), and counter examples are very rare. Several theories have been formed explicitly adopting this as a systematic gap, which we return to in §4.

Only a small number of counter-examples have been put forward, none without controversy. One comes from Nez Perce (Deal & Wolf 2017, introduced above), in which a few morphemes have phonologically-conditioned suppletive allomorphs. One example is the root √GO which is realized as *kiy-* before a vowel but as *kuu-* otherwise (this has a reduced variant *ku-*, based on stress). Deal & Wolf emphasize that there is no general i(y)~u(u) alternation in the language. They summarize the triggering contexts as in Table 5 (slightly modified from the original), which demonstrates that allomorph selection is determined by whether the following suffix is V- or C-initial. The segment which conditions allomorphy is part of a morph in an outer position, therefore constituting inward-conditioning (outward-sensitivity).[9]

[√GO] ↔ kiy- / ___ V		vs. [√GO] ↔ kuu (else)			
kiy-<u>u'</u>	go-PROSP.ASP	**kuu**-<u>se</u>-∅	go-IPFV.SG-PRES	**kuu**-<u>qa</u>-qa	go-PST.HAB-REC.PST
kiy-<u>uu</u>-se-∅	go-APPL-IPFV.SG-PRES	**ku**-<u>siix</u>-∅	go-IPFV.PL-PRES	**kuu**-<u>s</u>-∅	go-P.ASP-PRES
kiy-<u>ey'</u>-se-∅	go-μ-IPFV.SG-PRES	**kuu**-<u>tetu</u>-∅	go-HAB-PRES	**kuu**-<u>t</u>	go-NMLZ
kiy-<u>aatk</u>-sa-∅	go-take.away-IPFV.SG-PRES	**ku**-<u>t'ipec</u>	go-FREQ		

Table 5: Nez Perce inward-conditioning from a phonological trigger

Wolf (2013) presents several other (potential) examples of inward-conditioning from a phonological trigger, e.g. the Icelandic participle suffix is /-ð/ if before a vowel-initial suffix, but otherwise /-ɪn/ (Svenonius 2012).

Like Nez Perce √GO, one place we might expect to find inward-conditioning is with root/stem allomorphs, especially in light of how extremely common they are the targets of allomorphy with morphosyntactic triggers. However, this too is rare and subject to varying interpretations. This can be illustrated with languages in the Kiranti family. Across this family, stems generally have two related shapes (Herce 2020). Herce shows that in the Western branch, this is generally morphologically conditioned, but in the Eastern branch it is conditioned by whether the following suffix begins with a vowel or a consonant.

Consider Limbu [lif] (Van Driem 1987). Verb stems in general have two forms which differ in their final segments, e.g. a root √RETURN is realized as *nu·ks* before a vowel but *nu·ŋ* otherwise (e.g. before a consonant or word-finally). This is illustrated with the paradigm in Table 6 (Van Driem 1987:374-375), where preterit and non-preterit forms are provided with the full range of subject agreement morphology. When the root is before a vowel-initial suffix (the grey cells), it is always realized as *nu·ks*. The set of triggers do not form a morphosyntactically natural class.

	Non-preterit	Preterit
1S	**nu·ŋ**-ʔɛ	**nu·ks**-aŋ
1D.EX	**nu·ŋ**-si-ge·	**nu·ks**-ɛ-tchi-ge·
1D.IN	a-**nu·ŋ**-si	a-**nu·ks**-ɛ-tchi
1P.EX	**nu·ks**-i-ge·	**nu·ŋ**-ŋʔna
1P.IN	a-**nu·ŋ**	a-**nu·ks**-ɛ
2S	kɛ-**nu·ŋ**	kɛ-**nu·ks**-ɛ
2D	kɛ-**nu·ŋ**-si	kɛ-**nu·ks**-ɛ-tchi
2P	kɛ-**nu·ks**-i	kɛ-**nu·ks**-i
3S	**nu·ŋ**	**nu·ks**-ɛ
3D	**nu·ŋ**-si	**nu·ks**-ɛ-tchi
3P	mɛ-**nu·ŋ**	mɛ-**nu·ks**-ɛ

Table 6: Limbu inward-conditioning based on whether suffix is V-initial (grey) or not

There are several complicating factors, however, which undermine a straightforward interpretation as phonologically-conditioned allomorphy. One is that virtually all roots have two stems in Limbu, and it is thus not an idiosyncratic property of a few morphemes as we would expect (as in Nez Perce). Van Driem catalogues the stem pairs based on the shape of their rhyme, showing several sub-regularities. This is summarized in Table 7, split up based on the elsewhere form of the root compared to its shape before vowels. This table shows that the stems *nu·ŋ* and *nu·ks* above are one of 81 such pairs in the language which have the same ŋ ~ ks alternation (row g. below). Certain pairings are quite common – e.g. 94 roots show pairs ending in k ~ kt – while others are occur with only 1 or 2 roots.

	Else	~	pre-V	*n*=		Else	~	pre-V	*n*=		Else	~	pre-V	*n*=
a.	p	~	pt	48	e.	m	~	ps	35	h.	V·	~	Vy	14
	p	~	b	22		m	~	ms	14		V·	~	V·y	3
b.	t	~	tt	86		m	~	m	12	i.	V	~	Vs	65
	t	~	r	15		m	~	md	6		V	~	Vr	20
	t	~	ʔr	10	f.	n	~	nd	76					
	t	~	tch	4		n	~	nch	6					
	t	~	s	1		n	~	r	4					
c.	k	~	kt	94		n	~	ʔr	4					
	k	~	g	39		n	~	tch	2					
	k	~	ʔg	1	g.	ŋ	~	ks	81					
d.	ʔ	~	ʔr	44		ŋ	~	ŋ	35					
	ʔ	~	r	2		ŋ	~	ŋs	20					
	ʔ	~	·r	2		ŋ	~	ŋd	6					
	ʔ	~	ʔt	2		ŋ	~	g	1					
	ʔ	~	ʔs	1										

Table 7: Summary count of Limbu stem alternations (V = any vowel, · = long vowel)

While many of these pairings can be explained straightforwardly as neutralization in coda position[10], many pairs show phonologically odd alternations, such as m ~ ps, or ʔ ~ r. Moreover, as emphasized by Herce (2020) certain pairs have considerable overlap which complicates a straightforward phonological account, e.g. forms which end in [r] pre-vocalically show the following pairings: t ~ r, ʔ ~ r, n ~ r, V ~ Vr, t ~ ʔr, ʔ ~ ʔr, and n ~ ʔr.

Regardless of one's interpretation of these facts, one notable fact is that across the Kiranti family's stem alternations (as typologized in Herce), there are no examples of 'strong suppletion' such as a hypothetical root *naks* before a vowel but *lu·ŋ* elsewhere. If such an example were found, it should certainly be brought to the attention of the morphology community.

3.2 Suprasegmentally-conditioned

The second type is **suprasegmentally-conditioned allomorphy**, where the trigger involves tone, stress, moraic/syllabic structure, prosodic constituency, *etc*. A showcase example comes Tzeltal [tzh], where perfective aspect has two suppletive allomorphs: *-oh* appears with monosyllabic stems and *-ɛh* appears elsewhere (Paster 2006:171, citing Brown 1996 and Walsh Dickey 1999:328-329).

(29) Tzeltal perfective allomorphy conditioned by syllable count of stem

a.	j-<u>al</u>-**oh**	'he has told something'
	s-<u>mah</u>-**oh**	'he has hit something'
	s-<u>kutʃ</u>-**oh**	'she has carried it'
b.	s-tikun-**ɛh**	'he has sent something'
	s-mak'lin-**ɛh**	'he has fed someone'
	s-kutʃ-laj-**ɛh**	'she was carrying it repeatedly'

The two mid vowels /o/ and /ɛ/ show no active alternations in Tzeltal, nor would such an alternation be phonologically natural based on syllable count.

Further, stress frequently conditions allomorphy. Consider the two English verbal suffixes *-ize* and *-ify*, with causative semantics (among other uses). Plag (1999:197) analyzes these as phonologically-conditioned suppletive allomorphs in complementary distribution: "*-ize* is generally preceded by trochaic or dactylic bases, i.e. it needs an unstressed or secondarily stressed syllable to its left" (e.g. *rándom-ize*, *hóspital-ize*, and neologisms like *ghétto-ize*), "whereas *-ify* always needs a main-stressed syllable to its left (stress shift is generally avoided)" (e.g. *júst-ify, opác-ify,* and neologisms like *yúpp-ify*).

Parallel patterns exist involving tone conditioning suppletive allomorphy. One case is from the Yucunany dialect of Mixtepec Mixtec [mix] (Paster 2006, citing Paster & Beam de Azcona 2005). The first person singular enclitic is realized as a floating low tone by default, except when the phrase already ends in a low tone, where instead the allomorph *yù* is used. This is shown in (30). Stems ending in H (a.) or M tone (b.) select the floating Ⓛ allomorph, which results in a surface contour tone. In contrast, stems which end in L select *yù* (c.).

(30) Tone-triggered allomorphy in Mixtepec Mixtec (Paster 2006:128)

a.	vílú + **Ⓛ**	→	vílú**ù**	'**my** cat'
	nàmá + **Ⓛ**	→	nàmá**à**	'**my** soap'
b.	tzàákū + **Ⓛ**	→	tzàákū**ù**	'**my** coral'
	kwà'ā + **Ⓛ**	→	kwà'ā**à**	'**my** sister'
c.	tūtù + **yù**	→	tūtù **yù**	'**my** paper'
	chá'à + **yù**	→	chá'à **yù**	'**I** am short'

The suprasegmental cases identified in the literature show the same directional asymmetry that we saw with segmentally-conditioned allomorphy: the trigger is inward and the target is outward, thus constituting outward-conditioning. Counter-examples are rare and generally treated cautiously. One example comes from Surmiran Rumantsch [roh] stem suppletion (Anderson 2008, Wolf 2013), which can be taken as the suprasegmental version of the Limbu patterns we saw before in Table 6. In this language, there are a number of vowel alternations which are conditioned by stress. Most stems have two forms: one used when the stem is unstressed and the suffix is stressed, and another when the stem is stressed and suffix unstressed. Two representative examples are shown in Table 8. For typographical clarity, in the Rumantsch data stress is indicated via an acute accent on the vowel rather than a stress mark.

	'sleep'	'get up'
1S	**dórm**	**lév**
2S	**dórm**-as	**lév**-as
3S	**dórm**-a	**lév**-a
1P	**durm**-ígn	**lav**-ágn
2P	**durm**-íz	**lav**-éz
3P	**dórm**-an	**lév**-an
INF	**durm**-éir	**lav**-ár

Table 8: Surmiran Rumantsch stem alternations (Anderson 2008:113)

Anderson states that while these alternations have transparent diachronic origins, in the synchronic system there are too many unpredictable aspects to derive them through phonology alone. Rather, they constitute phonologically-conditioned suppletive allomorphs. Consider Table 9. A core argument that this constitutes suppletion is because "the relationship between the stressed and unstressed vowels is many-to-many", e.g. "both [a] and [o] in the stressed form can alternate with any of /ə, ɪ, ʊ/ in the unstressed form" (Wolf 2013:166), shown in rows a. and b. Other more complicated vowel alternations are common as well (c.).

Alternation		Unstressed stem (INFINITIVE)		Stressed stem (3.SG.PRES.INDIC)		Verb root
a.	ə~á	*levar*	l**[ə]**v-ár	*lava*	l**[á]**v-a	'wash'
	ɪ~á	*(sa) tgilattar*	tgil**[ɪ]**tt-ár	*tgilatta*	tgil**[á]**tt-a	'sit down'
	ʊ~á	*vurdar*	v**[ʊ]**rd-ár	*varda*	v**[á]**rd-a	'watch'
b.	ə~ó	*clamar*	cl**[ə]**m-ár	*cloma*	cl**[ó]**m-a	'call'
	ɪ~ó	*dumignar*	dum**[ɪ]**gn-ár	*dumogna*	dum**[ó]**gn-a	'dominate'
	ʊ~ó	*crudar*	cr**[ʊ]**d-ár	*croda*	cr**[ó]**d-a	'fall'
c.	i...i~ə...é	*angivinar*	ang**[i]**v**[i]**n-ár	*angiavegna*	angi**[ə]**v**[é]**gn-a	'solve'
	u...∅~ə...óu̯	*luvrar*	l**[u]**vr-ár	*lavoura*	l**[ə]**v**[óu̯]**r-a	'work'
	u...ə~ú...∅	*sbusarar*	sb**[u]**s**[ə]**r-ár	*sbusra*	sb**[ú]**sr-a	'go wrong'

Table 9: Surmiran Rumantsch stem allomorphs

If we accept these as distinct allomorphs following Anderson and Wolf, then realizational rules such as the following can be posited:

(31) [√WASH] ↔ *ləv-* / ___ V́ (stressed vowel)
lav-

The selection of the stem allomorph is sensitive to a phonological property (stress) on an outer suffix, and thus this constitutes inward-conditioning.[11]

A few other cases of inward-conditioning from a suprasegmental trigger have been proposed. In Cilungu [mgr] (Bickmore 2007, 2014), Rolle & Bickmore (*accepted*) argue that the tone of an outer affix (subject agreement marker) conditions allomorphy of the grammatical tone associated with an inner affix (tense and aspect). A key part of their analysis is that an alternative phonological account requires typologically unprecedented phonological operations, e.g. a first-last tone harmony rule where the initial vowel and final vowel of the word must have identical tone values. Further, in Armenian there are competing views of inward-conditioning for certain allomorphy pairs, as well (Wolf 2013; but cf. Arregi, Myler, & Vaux 2013). In total, regardless of whether inward-conditioning with a phonological trigger is a true empirical gap or simply very rare, it constitutes a clear directional asymmetry which morphologists must contend with.

4 Directional (a)symmetry and morphological theory

To wrap up this chapter, I will situate the primary patterns within the larger theoretical literature. I have presented thus far a summary of five main types of allomorphy. These are summarized in Table 10 as rows a.-e. Each is marked with one of three values for the two directions (inward and outward). If the morphology literature contains a large enough examples then this is labelled '**Sufficient**' and should be interpreted as empirically attested. If there were no incontrovertible examples and no overt arguments for this pattern, it was labelled as **'Insufficient**' and should be interpreted as empirically unattested at this point. As it stands, only inward-conditioning from a lexical trigger (row a.) falls under this category. Finally, if examples exist but they are infrequent and/or contested, it was labelled as '**Limited**'.

		[[[○] ○] ⟶ •] NUCL TRIG TARG	[[[○] •] ⟵ ○] NUCL TARG TRIG	
	Type	**Outward-conditioning (Inward-sensitivity)**	**Inward-conditioning (Outward-sensitivity)**	**Directional (a)symmetry**
a.	Lexically-conditioned	Sufficient	*Insufficient*	Asymmetrical
b.	Grammatically-cond. (category & feature)	Sufficient	Sufficient	Symmetrical
c.	Morphologically-cond.	Sufficient	*Limited*	Asymmetrical
d.	Syntactically-cond.	*Limited*	*Limited*	(Symmetrical)
e.	Phonologically-cond. (segmental & suprasegm.)	Sufficient	*Limited*	Asymmetrical

Table 10: Summary of allomorphy patterns and directional asymmetries

Based on this table, there are two key generalizations which morphological theory must contend with. The first is that there is a symmetry in grammatically-conditioned allomorphy, with both inward- and outward-conditioning well-attested. This is the only clear case of directional symmetry; cases of syntactically-conditioned allomorphy are too contestable at this point to include them. The second generalization is that the other types of allomorphy all show the same directional asymmetry: outward-conditioning is well-attested but inward-conditioning is not. This asymmetry holds whether one views these as true gaps or merely very rare. We can call this the '**directional asymmetry in allomorphy selection**'.

(32) Directional asymmetry in allomorphy selection:
Cross-linguistically, all trigger types show outward-conditioning (the target is in an outer position), though not all trigger types uncontroversially show inward-conditioning (the target is in an inner position)

Trigger type here refers to one of the broad categories from Table 10 (e.g. lexical, grammatical, phonological, *etc*.).

Regarding the first generalization (directional symmetry with grammatically-conditioned allomorphy), it is interesting to note that several morphological models have been posited which do *not* predict this symmetry. One proposal is from Carstairs-McCarthy (2001), who argues that outward-conditioning (inward-sensitivity) "should be [from] individual properties" such as morphosyntactic features like [PAST], while inward-conditioning (outward-sensitivity) "should be only [from] whole categories" such as Tense (p. 42). However, as we saw in §2.2 there is directional symmetry between all types of grammatically-conditioned allomorphy which contradicts the predictions of this model. See also Adger, Béjar, & Harbour (2003) for rebuttal arguments based on (generative) syntactic theory.

Furthermore, within early Distributed Morphology (DM) works (and many thereafter), there is a common desideratum to model grammatically-conditioned allomorphy as only going inward (at odds with the directional asymmetry above). This is succinctly summarized in Gouskova & Bobaljik (ms.) discussing previous work on Itelmen (Bobaljik 2000, Bobaljik & Wurmbrand 2001) introduced in §2.2. Examining allomorphy within the verb, Gouskova & Bobaljik highlight the fact that grammatically-conditioned allomorphy (from morphosyntactic features such as person, number, and mood) displays inward-conditioning (outward-sensitivity), while allomorphy which is phonologically-conditioned or morphologically-conditioned (from morphological features such as root-specific conjugation classes) displays outward-conditioning (inward-sensitivity). This falls out from the concept of '**cyclic exponence**' in which the features of the most deeply embedded node are realized first, with exponence proceeding inside-out one-by-one. To quote Gouskova & Bobaljik:

> *"This asymmetry in the direction of conditioning can be seen as an effect of the cyclic, bottom-up (root-outwards) application of VI [Vocabulary Insertion], converting a morphosyntactic representation to a morphophonological one: When VI applies to any given node, more peripheral nodes are still abstract, consisting only of morphosyntactic information, thus only that information is available outwards. Conversely, since lower nodes have already been converted to a phonological string, only information in the phonological representation, including inflection class diacritics, is visible for inwards-sensitive conditioning."*

Within this model the underlying morphosyntactic features must be 'rewritten' ~ 'replaced' when a realizational rule applies. Following the authors, this process is illustrated using the basic syntactic tree in Figure 1, followed by their envisioned morphological procedure in (33).

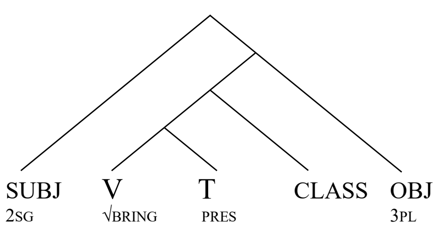

Figure 1: Itelmen verb-internal hierarchical structure (Gouskova & Bobaljik ms.)

(33) Itelmen cyclic exponence (inside-out and one-by-one)

a.	Input:	[S:2SG [[[[√BRING] PRES] CL] O:3SG]]
b.	Step 1:	[S:2SG [[[[tɸɬ]$_2$ PRES] CL] O:3SG]]
c.	Step 2:	[S:2SG [[[[tɸɬ]$_2$ z] CL] O:3SG]]
d.	Step 3:	[S:2SG [[[[tɸɬ]$_2$ z] čŋ] O:3SG]]
e.	Step 4:	[S:2SG [[[[tɸɬ]$_2$ z] čŋ] in]]
f.	Step 5:	[Ø [[[[tɸɬ]$_2$ z] čŋ] in]]
g.	Surface:	[tɸsčŋin] 'you are bringing it'

Because exponence is cyclic and morphosyntactic features are replaced in this model, this predicts that allomorphy can only be sensitive to morphosyntactic of *outer* nodes. For Itelmen this holds up. For example, the realization of the class morpheme CL is sensitive to the morphosyntactic features of outwardly located subject and object agreement, while the realization of object agreement is sensitive only to outwardly located subject agreement features.

Despite the success for Itelmen, an empirical conclusion of this chapter is that grammatical allomorphy of this type is incontrovertibly bidirectional. Their model therefore requires a modification: either the morphosyntactic features are not replaced, or the exponent is labelled in such a way that the original morphosyntactic features are recoverable (for the latter, see Adger, Béjar, & Harbour 2003).

Models with cyclic exponence achieve more success with respect to morphologically- and phonologically-conditioned allomorphy. Recall from Table 10 that these types show a clear selectional asymmetry: the great majority of cases involve outward-conditioning (inward-sensitivity), equally true of the Itelmen data above. Many theoretical works adopt that the dearth of convincing cases showing inward-conditioning necessitates a maximally restrictive model like cyclic exponence, where such cases are principally ruled out by the architecture of grammar. This holds for virtually all of the DM literature (e.g. Embick 2010, 2015) and some additional non-OT based morphology (Paster 2006), as well as some OT-based models like Optimal Construction Morphology (Caballero & Inkelas 2013, Inkelas 2017).

For example, consider the bottom-up construction of words in Optimal Construction Morphology (OCM), using data from Archi [aqc] (Kibrik 1991). As shown in (34), ergative marking has a special form -*čaj* when it is next to a plural marker, glossed as ERG.PL.

(34) Archi ergative allomorphy

a.	gel-li	cup-ERG.SG	gel-<u>um</u>-**čaj**	cup-<u>PL</u>-**ERG.PL**
b.	qIonn-i	bridge.ERG.SG	qIonn-<u>or</u>-**čaj**	bridge-<u>PL</u>-**ERG.PL**

Under OCM's implementation of cyclic exponence, these Archi data entail that inner morphosyntactic features are not replaced, otherwise we would expect the replacement of the inner plural feature by a plural morph (allomorphs -*um* or -*or* above) to bleed the insertion of the special ERG.PL form. Instead, the relevant morphosyntactic features are stable and exist as an independent 'S-target' accompanying the derivation. These features are not subject to addition, deletion, or replacement.

An abridged version of Caballero & Inkelas' OCM derivation of the Archi data is in Table 11. At the top is the S-target consisting of semantic features [SEM=CUP, NUM=PL, CASE=ERG], which is able to be referred to at any stage of the derivation. The individual steps gradually realize these features (inside-out, starting from the root). Because the number feature PL is always available in the S-target, it can condition the special ergative form. Note that the authors implement the input-output mapping within Optimality Theory using constraint ranking and candidate competition, not shown.

S-target:	[SEM=CUP, NUM=PL, CASE=ERG]		
	Input:		Output:
Step ①	Ø	→	$[\text{gel}]_{Root}$ SEM=CUP
Step ②	$[\text{gel}]_{Root}$ SEM=CUP	→	$[\text{gel-um}]_{Stem}$ SEM=CUP NUM=PL
Step ③	$[\text{gel-um}]_{Stem}$ SEM=CUP NUM=PL	→	$[\text{gel-um-čaj}]_{Word}$ SEM=CUP NUM=PL CASE=ERG

Table 11: Optimal Construction Morphology analysis of Archi

One of the drawbacks of the DM and OCM models employing cyclic exponence is that it is a victim of its own success: how do they account for the small number of cases involving outward-conditioning of a phonological or morphological trigger? Such cases are not derivable given the strictest version of this architecture. One solution is to allow for the cyclic exponence to generally proceed inside-out but allow for a restricted number of contexts where a more outwardly located feature is realized before a more inwardly located one (i.e. in [[x]-y]-z, realize z before y). In this way, morphophonological information associated with a particular outer morph will be available even to inner morphs. For strategies how this could be implemented, see distinct proposals in Wolf (2008) and Myler (2017).

An even more radical departure is in Optimality Theoretic Distributed Morphology (OT-DM) (Rolle 2020, Rolle & Bickmore *to appear*), whereby all features are realized simultaneously within a single instance of spell-out, i.e. '**simultaneous exponence**'. Such a model predicts there to be both inward and outward-conditioning of all types. Because this is a less restrictive theory of allomorphy, it begs the following question: why do we see such limited and controversial cases of inward-conditioning involving phonological and morphological triggers? One cannot refer strictly to linguistic architecture under simultaneous exponence, and therefore a more sophisticated response is necessary involving diachronic, cognitive, or usage-based supplements.

Our discussion thus far has touched upon only part of the theoretical morphology literature. Another prominent group of morphological theories largely rejects the morph/morpheme as the primary unit of morphological contrast (e.g. 'A-morphous' approaches *à la* Anderson 1992), instead examining morphology as functions (Paradigm Function Morphology – Stump 2001) and/or as paradigms (Word & Paradigm Morphology – Blevins 2016). Under these approaches, the role of allomorph selection generally is minimized (if not entirely rejected), as is word-internal hierarchical structure and with it debates concerning directionality.

While these models minimize allomorphy selection as a whole, other models go in the opposite direction and consider many alternations as stored allomorphy which most morphophonologists would consider simply to be regular phonology. Consider the 'Emergent Morphology' program (Archangeli & Pulleyblank 2015, 2016, *i.a.*), which eschews underlying representations. Instead, it posits that all surface allomorphs are underlyingly stored and selected under certain conditions, e.g. English plural marking forms a set {s,z,əz,fit$_{\text{FOOT}}$,tiθ$_{\text{TOOTH}}$,mais$_{\text{MOUSE}}$,…}$_{\text{PLURAL}}$, where surface forms [s,z,əz] are stored rather than being derived from underlying /z/.

This expansion of what constitutes (suppletive) allomorphy has a radical effect on the typology of directionality effects, especially with regard to phonologically-conditioned allomorphy. To illustrate, consider an example from Standard Yoruba (Archangeli & Pulleyblank 2016:262-265). Yoruba has three tone heights: high, mid, and low. A general contouring rule exists whereby a high tone (H) spreads rightward into a following low tone (L) (i.e. H.L → H.HL), and L spreads rightward into H (i.e. L.H → L.LH). That this is a general process (i.e. not morphologically-conditioned) is seen in (35), where every syllable but the last spreads its tone rightward.

(35) Yoruba tone contouring (Hyman 2007, citing Laniran & Clements 2003)
/ máyọ̀mí rà wé / → [máyộmǐ râ wě] 'Mayomi bought books'

The standard analysis of such data is to derive the contour via a phonological rule, and posit an underlyingly representation such as /rà/ 'buy' in (35). Under Emergent Morphology, however, morphemes form sets of allomorphs selected under certain conditions. In (36) below, the verb 'see' consists of the set {rí,rǐ} where the allomorph /rí/ is selected after a high tone but /rǐ/ after a low tone (the latter to avoid a marked L.H sequence across syllables). As done throughout, the allomorphs are in bold and the trigger is underlined.

(36) Yoruba tone alternations (Archangeli & Pulleyblank 2016)
a. ó **rí** 3SG **see** 'he/she/it saw'
b. kò **rǐ** NEG **see** 'he/she/it did not see'

Here, the trigger is phonological and part of a morph (the subject) in an outer position, therefore constituting inward-conditioning (i.e. outward sensitivity). Such an interpretation would make this Yoruba case like the stem allomorphy we saw for Limbu and Surmiran Rumantsch in §3.[12]

The inclusion of fully predictable allomorphs would drastically effect our conclusions, and any directional asymmetry in phonologically-conditioned allomorphy would likely dissipate. While the Emergent Morphology approach deserves to be judged in its own right, it is not well-suited for the typological perspective of this chapter.[13]

5 Conclusion

This chapter provided an overview of directionality relations in allomorphy selection. One type was 'inward-conditioning' (a.k.a. outward-sensitivity), where the trigger was in a structurally outer position compared to the inner target (i.e. it is further away from the lexical head of the construction). Its counterpart was 'outward-conditioning' (a.k.a. inward-sensitivity), where it was the trigger that was in an inner position and the target in an outer position. A number of typologically diverse cases were presented to illustrate directional asymmetries in allomorphy selection. One key generalization involved grammatically-conditioned allomorphy, in which the trigger was a morphosyntactic feature (e.g. [PLURAL]), feature bundle (e.g. [3.SG.FEM]), or category (e.g. [TENSE]). In this type of allomorphy, both inward-conditioning and outward-conditioning were widespread, showing directional symmetry. In contrast, other types such as lexically-conditioned (the trigger is a particular lexical root), morphologically-conditioned (a purely morphological feature, e.g. conjugation class), and phonologically-conditioned allomorphy showed a clear directional asymmetry. Here, allomorph selection almost always involved outward-conditioning, i.e. the trigger was in an inner position and the target more outwards. Cases of inward-conditioning remain rare and controversial. Taken all together, these findings were summarized as a typological statement called the 'directional asymmetry in allomorphy selection'. Finally, as was emphasized it is important to keep in mind that analyses as (arbitrary) allomorphy should be accepted only if more-grounded explanations have been tried and discarded first. Fine phonological and syntactic analyses are always required as a baseline.

SEE ALSO: [morphcom007, morphcom038, morphcom050, morphcom051, morphcom054, morphcom062, morphcom077]

Acknowledgments

I would like to thank Sabrina Bendjaballah and the editorial team of this volume, as well as Hossep Dolatian for a thorough reading of this manuscript and many great discussions on these issues.

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[1] Different authors highlight different criteria for deciding whether two allomorphs are suppletive or not. Literature emphasizing whether the forms are phonologically distinct ("maximally irregular in form" in the Surrey Suppletion Database – Brown *et al.* 2003) include Carstairs (1990:17), Mel'čuk (1994), Veselinova (2006), Corbett (2007), Bobaljik (2012), Bauer (2016:341), and Smith *et al*. (2019:1030). Other parts of the literature emphasize the generalizability of the alternation and/or the underivability of one morph from the other, e.g. Carstairs (1990:18), Mel'čuk (1994:390), Veselinova (2006:*xv*,47ff), Embick (2010:43), Bonet & Harbour (2012), Inkelas (2014:153-154 fn5), and Paster (2016:96). A smaller number of works emphasize the phonological, phonetic, and typological plausibility of a potential rule which would derive the forms from one underlying representation, e.g. Kiparsky (1996) and Paster (2006, 2016).

[2] While it is not entirely settled what constitutes a natural from unnatural alternation, efforts have been made to identify cross-linguistically common processes (Mielke 2008, Brohan & Mielke 2018) as well as the computational properties which underlie them (Heinz 2018, and references therein). For several of the case studies in this overview, one may argue about the naturalness of the alternation. We take this as simply one of several criteria to consider, and each individual case must be assessed as to how the allomorphy data fit into the language's larger phonology.

[3] This is a simplification. There is arguably a null realization Ø, too.

[4] For example references, see Choi & Harley (2019:1342fn25).

[5] The orthography here follows the Deak *et al.* source. See Austin (1981:213) for other information on surface allomorphy with the ergative and locative.

[6] This makes the prediction that we should find contexts showing both directions simultaneously. Indeed, several allomorphic rules have been posited involving two triggers, one inward and the other outward. One is Hupa [hup] (Embick 2010:61, citing Golla 1970:69), whereby agreement features [1SG] are conditioned by outwardly-located aspect [PERF] as well as the inwardly located eventivity/stativity of the verb.

[7] For our purposes, we ignore a set of an exceptional group of nouns which take the *den* form in all contexts.

[8] A percentage of speakers also get the restrictive reading here, as well.

[9] See Kiparsky (2021), however, for a counter analysis.

[10] This interpretation seems plausible since the only consonants allowed in coda position are in fact [p b pʰ k t tʰ ʔ m n ŋ].

[11] Wolf (2008:194-195) mentions similar non-predictable stem alternations in Italian, e.g. the root √BREAK (infinitive *rompere* 'to break') is *rupp-* when stressed but *romp-* when unstressed, √GO.OUT (infinitive *uscire* 'to go out') is *esc-* when stressed but *usc-* when unstressed, among a few others.

[12] An Emergent Morphology approach involving fully predictable allomorphs has been particularly attractive in modeling phonologically-unnatural patterns of tone sandhi, going back at least to Tsay & Myers (1996).

[13] In fact, I have not included psycholinguistic approaches to morphology in general. This is relevant given the debates concerning the storage vs. computation of complex linguistic forms that have taken place there, where the role of predictability in linguistic storage is examined very carefully (e.g. Nooteboom, Weerman, & Wijnen 2002).