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1 Introduction

Morphological paradigms are a mainstay of traditional descriptions of inflectional systems and of diachronic change. Only in recent years, however, have paradigms played a formal role in the grammatical analysis of phonological systems, in the form of correspondence constraints and contrast constraints on paradigmatically related forms. In this chapter I review some of the evidence that has been taken to indicate that paradigm structure plays an active role in synchronic phonology, and discuss some of the grammatical mechanisms that have been proposed to capture such effects, focusing especially on work within Optimality Theory (OT: **Prince and Smolensky 2004**).

It must be acknowledged at the outset that one cannot meaningfully discuss phonological paradigm effects without a precise definition of “paradigm.” I begin by adopting a very general and widely assumed definition: a paradigm is the exhaustive set of inflected forms that share a single root or stem – e.g. inflected case and number forms of a noun, or person, number or tense/aspect/mood forms of a verb. In some cases, phonology treats all inflected forms of a root alike, and this broad definition suffices. In many cases, however, it is necessary to restrict the domain of discussion to a specific subset of inflected forms that constitute a local subparadigm – e.g. the set of verb forms that share present tense subjunctive inflection (the “present subjunctive paradigm”), or the set of noun forms that share dual inflection (the “dual paradigm”). For the purpose of illustrating paradigm effects and their analysis, I will simply stipulate the scope of the effect as necessary; in §4, I return to the issue of the formal definition of paradigms.

An important related issue is whether phonological paradigm effects are conditioned by the same type of paradigm structure that is posited by paradigm-based theories of morphology, such as Word-and-Paradigm Morphology (**Hockett 1954**; **Matthews 1965**; **Zwicky 1985**; **Anderson 1986**) or Paradigm Function Morphology (**Stump 2001**). On the face of it, paradigm-based theories of morphology seem especially well suited for capturing phonological paradigm effects, since they provide a representational unit (the “paradigm”) that can be used to condition morphological and phonological grammar distributions. The use of phonological paradigm constraints does not presuppose the existence of paradigms as morphological representations, however. In fact, the phonological constraints described in §3 make very limited use of morphological structure: if two forms share a root and all derivational affixes, then they are treated by the phonology as members of the same inflectional paradigm. Although arguments against morphological and phonological uses of paradigms are often presented side by side (e.g. **Bobaljik 2008**), it appears that the question of whether morphology is paradigm-

based may be orthogonal to the question of whether phonology imposes constraints on relations between inflectionally related forms. The current chapter focuses on the role that paradigmatic relations play in conditioning phonological distributions, and leaves aside arguments for and against paradigms as morphological representations. A long-term goal, beyond the scope of this chapter, would be to establish whether morphological and phonological distributions rely on a common set of representational units, or whether phonological constraints make only indirect reference to morphological representations.

In this chapter, I consider a variety of effects that demonstrate a role for paradigms in phonological grammar. Before turning to the analysis of synchronic paradigm effects, however, it is useful to review briefly the type of data that have traditionally been taken as evidence that phonological processes are sensitive to paradigm structure, drawn from the domain of language change.

1.1 Paradigms as a factor in conditioning diachronic change

It is often convenient to present complex inflectional systems in tabular form, with each cell in the paradigm representing a particular combination of morpho-syntactic features. In some theories of morphology, paradigms are taken to be not merely a matter of descriptive convenience, but also a grammatically relevant representation of the distribution of inflectional markers (Hockett 1954; Matthews 1965; Anderson 1986; Wurzel 1989; Stump 2001; Blevins 2003; Ackerman *et al.* 2009). According to proponents of paradigm-based models, representations in terms of paradigms permit concise or insightful statements about morphological distribution that would be difficult to capture if each morpheme were represented individually. For instance, patterns of syncretism and alternation are often shared across multiple inflection classes, suggesting that a paradigmatic template is in force (Williams 1994; Baerman *et al.* 2005; Maiden 2005; though see Bobaljik 2002 and Harley 2008 for alternative approaches). An example is seen in Modern German, which has stem vowel alternations in the 2nd and 3rd singular present tense forms of many verbs. These alternations can be traced back to historically unrelated raising processes, but the conditioning context (originally, high vowels in the suffix) is no longer present in the modern language, nor can the various changes found in the 2nd and 3rd singular be straightforwardly unified as the same featural change. Thus it appears that the broadest generalization one can make is that the 2nd and 3rd singular differ from the rest of the paradigm in having a raised and/or fronted vowel. This relation cannot be captured by a single (morpho)phonological rule, but can be characterized by a template in which the 2nd and 3rd singular forms differ from the remaining forms.

(1) *Vowel alternations in German present tense indicative verb forms*

Verb	'travel'	'run'	'give'	'see'
INF	fa:ɪən	laʊfən	ge:bən	ze:ən
1SG	fa:ɪ(ə)	laʊf(ə)	ge:b(ə)	ze:(ə)
2SG	fɛ:ɪst	lɔɪfst	gɪbst	zɪst
3SG	fɛ:ɪt	lɔɪft	gɪbt	zɪt
1PL	fa:ɪən	laʊfən	ge:bən	ze:ən
2PL	fa:ɪt	laʊft	ge:ɪt	ze:t
3PL	fa:ɪən	laʊfən	ge:bən	ze:ən

A compelling source of evidence for a paradigmatic effect comes from language change: in fact, verbs like [ge:bən] 'give' and [ze:ən] 'see' originally showed a different distribution, in which the 1st singular had the same vowel as the 2nd and 3rd singular: [gibə], [gɪbst], [gɪbt]. The change of 1st singular [gibə] → [ge:bə] to match the vowel of the plural and infinitive appears to have been motivated by the influence of verbs like [fa:ɪən] 'travel', in which raising has always been limited to the 2nd and 3rd singular (Paul *et al.* 1989: 243).¹ Put differently, a prevalent pattern of alternation within the paradigm (2nd and 3rd singular vs. others) was generalized to verbs with a similar but less robustly attested pattern (singular vs. plural). Such changes are often taken as evidence that speakers evaluate the relations between forms within paradigms, and that language change may enforce or regularize such relations.

1.2 Paradigm uniformity in language change

One common way in which paradigmatic relations are strengthened is by loss (or "leveling") of alternations among inflectionally related forms. A widely discussed example comes from immediately pre-classical Latin, in which [s] ~ [r] alternations created by rhotacism of intervocalic stridents were leveled to invariant [r] (Hock 1991: 179–190; Barr 1994; Kenstowicz 1996; Hale *et al.* 1997; Kiparsky 1998; Baldi 1999: 323; Albright 2005).

(2) Leveling of rhotacism alternations in Latin honor

	Stage 1	Stage 2
NOM SG	hono:̄s	hono:̄r
GEN SG	hono:ris	hono:ris
DAT SG	hono:ri:	hono:ri:
ACC SG	hono:rem	hono:rem
ABL SG	hono:re	hono:re

Crucially, the change of [s] to [r] in [hono:s] → [honor] took place only within the inflectional paradigm, while derivationally related forms such as [hones-tus] ‘honorable’, [honoes-te:] ‘honorably’, and [hones-ta:s] ‘honorableness’ remained unchanged. Furthermore, [s]-final nouns that had no inflected forms with [r], such as the indeclinable noun [nefa:s] ‘sacrilege’ (related to the derived adjective [nefa:r-ius] ‘wicked’), also remained unchanged, as did [s]-final words in other parts of speech, such as the adverb [nimis] ‘excessively’. These facts show that the change of [s] to [r] was not part of a broader sound change extending rhotacism to the word-final position. Furthermore, if we assume that forms like [hones-tus] remained synchronically linked to the related noun [honor], the change cannot be viewed as a re-analysis to /honor/ by learners missing the presence of [s] ~ [r] alternations (Vincent 1974). Such examples are often taken as evidence that the domain of analogical leveling is the inflectional paradigm.

Another common feature of paradigm leveling is that it may affect only a subset of the inflectionally related forms. For example, several classes of Middle High German (MHG) verbs showed vowel alternations between the singular and plural, with the infinitive always matching the vowel of the plural, and the past participle frequently showing yet a different vowel. In Yiddish, these alternations have been eliminated completely in some verbs (3a), while they have been leveled only among present tense forms for others (3b). We may plausibly suppose that the infinitive and finite present tense forms of /visən/ ‘know’ remain synchronically related, but the identity of the 1st/3rd plural and infinitive has been abandoned in favor of an invariant verb stem within the subparadigm of present tense forms (Albright 2010).

(3) Full and partial leveling in Yiddish

a. ‘need’			b. ‘know’		
	MHG	Yiddish		MHG	Yiddish
INF	<i>dürf-en</i>	<i>darf-ŋ</i>	INF	<i>wiz̄z-en</i>	<i>vis-ŋ</i>
1SG	<i>darf</i>	<i>darf</i>	1SG	<i>wēiz̄</i>	<i>veis</i>
2SG	<i>darf-t</i>	<i>darf-st</i>	2SG	<i>wēis-t</i>	<i>veis-t</i>
3SG	<i>darf</i>	<i>darf-(t)</i>	3SG	<i>wēiz̄</i>	<i>veis</i>
1PL	<i>dürf-en</i>	<i>darf-ŋ</i>	1PL	<i>wiz̄z-en</i>	<i>veis-ŋ</i>
2PL	<i>dürf-t</i>	<i>darf-t</i>	2PL	<i>wis-t</i>	<i>veis-t</i>
3PL	<i>dürf-en</i>	<i>darf-ŋ</i>	3PL	<i>wiz̄z-en</i>	<i>veis-ŋ</i>
PAST PRT	<i>ge-dorft</i>	<i>ge-darft</i>	PAST PRT	<i>ge-wus-t</i>	<i>ge-vus-t</i>

Language change provides numerous examples of paradigmatic conditioning. However, we frequently cannot be certain whether the changes reflect a synchronic preference for non-alternating paradigms, or whether they represent lexical re-analyses on the part of learners. Such changes are difficult to interpret, because we cannot be sure that Latin speakers synchronically derived forms like [hono:s] and [hones-tus] (without rhotacism) from a single stem /hono:s/. If [hono:s] and [honestus] were derived from different stems, we could interpret the change as a re-analysis of the nominal stem from /hono:s/ to /honor/ (perhaps motivated by the preponderance of rhotacized [hono:s] forms), while the adjectival stem /hones/ remained intact. Similarly, although there is no reason to think that MHG speakers treated the infinitive and plural stems *wiz̄z-* and *wiz̄z-* as distinct, if for some reason they did encode them as separate stems, then we could simply say that Yiddish lost the plural stem while retaining the infinitive stem. In order to show that a phonological process misapplies within inflectional paradigms, we must demonstrate that the forms in question are synchronically derived from the same stem, and that the process in question continues to apply except when trumped by identity among paradigmatically related forms. In the following section, we review several cases with exactly this flavor: a phonological process continues to apply straightforwardly and productively in derived forms, but is overridden just in case greater identity between inflected forms would result.

2 Synchronic paradigm effects

The literature on synchronic paradigm effects has identified two opposing ways in which phonological relations among inflected words may be regulated: on the one hand, there is a tendency to demand identity among inflected forms, so that elements of shared meaning (the stem, shared inflectional markers) have a consistent phonological form throughout the paradigm (*uniformity*). At the same time, there is a tendency to avoid total identity between forms that are morphologically distinct (*anti-homophony*) (see also CHAPTER 103: PHONOLOGICAL SENSITIVITY TO MORPHOLOGICAL STRUCTURE). In both cases, it is claimed that the requirement of identity or distinctness may be enforced within the domain of the paradigm, while violations of identity between derivationally related forms, or violations of anti-homophony among unrelated forms, are not enforced. I

consider these two tendencies in turn. Paradigmatic conditions in phonology have been explored extensively in the past decade, and it would not be possible in a chapter of this length to do justice to the range and intricacy of empirical cases that have been brought to bear on the issue. For additional examples, the reader is referred to the collections of papers in **Hermans and van Oostendorp (1999)**, **Downing et al. (2005b)**, and **Bachrach and Nevins (2008)**.

Frequently, affixation creates or destroys the context for a phonological process to apply, leading to the possibility of alternations. This section discusses cases in which regularly expected alternations are avoided, and paradigmatic identity is seen instead. As is standard in the literature on identity effects in other domains, such as reduplication (**McCarthy and Prince 1995**), we may distinguish between cases where identity is achieved by applying a process outside its regular context (*overapplication*), by failing to apply a process within its regular context (*underapplication*), or by applying a process differently from how it would normally apply to a given phonological string (*misapplication*). It is also important to bear in mind that these phenomena are not substantively different from those that arise in cases of cyclicity in derived forms; therefore, much of the discussion of parallel facts in **CHAPTER 85: CYCLICITY** is relevant here as well.

Frequently, phonological processes apply outside their regular context, if doing so can achieve greater identity between related forms. For example, **Hayes (2000)** discusses a process in American English (and other varieties) in which coda /l/ becomes dark and creates a diphthongized allophone of the preceding vowel (**CHAPTER 31: LATERAL CONSONANTS**): /fi:l/ → [fiəɫ] *feel*, /faɪl/ → [faɪəɫ] *file*, /ɔɪl/ → [ɔɪəɫ] *boil*. This process does not normally occur intervocalically: [si:lɪŋ]/*[siəɫɪŋ] *celling*, [paɪləɫ]/*[paɪəɫəɫ] *pilot*, [tɔɪləɫ]/*[tɔɪəɫəɫ] *toilet*. However, at morpheme boundaries, coda velarization may apply. Hayes presents survey data documenting a variable or gradient pattern in which /l/ may be realized as [ɫ] before morpheme boundaries: *maɪ[ɫ]er*, (*touchy-*)*fee[ɫ]y*. The pattern that Hayes describes for his own speech involves overapplication of diphthongization and coda velarization before both inflectional and derivational affixes: [hiəɫɪŋ] *healing*, [mæəɫə] *mailer*. By contrast, in at least the present author's idiolect, coda velarization always overapplies, but diphthongization overapplies (optionally) only in inflected forms. The difference is most clearly heard (and intuited) after underlying diphthongs, where “diphthongization” yields so-called sesquisyllabic outcomes such as [bɔɪəɫ] *boil*. Crucially, the overapplication of diphthongization seems to occur only in inflected forms: *boiling* [bɔɪəɫɪŋ] *patiently* vs. *boiler* [bɔɪəɫə], *[bɔɪəɫəɫə].

(4) *Overapplication of pre-lateral diphthongization in one idiolect of American English*

<i>base</i>		<i>inflected</i>	<i>derived</i>	
[bɔɪəɫ]	<i>boil</i>	[bɔɪɪŋ], [bɔɪəɫɪŋ]	[bɔɪəɫə], *[bɔɪəɫəɫə]	<i>boiler</i> ('water-heater')
[spɔɪəɫ]	<i>spoil</i>	[spɔɪɪŋ], [spɔɪəɫɪŋ]	[spɔɪəɫə], *[spɔɪəɫəɫə] [spɔɪəɫɔɫ], *[spɔɪəɫəɫɔɫ]	<i>spoiler</i> (of plot) <i>spoilage</i>
[ɔɪəɫ]	<i>oil</i>	[ɔɪɪŋ], [ɔɪəɫɪŋ]	[ɔɪəɫə], *[ɔɪəɫəɫə]	(<i>Edmonton</i>) <i>Oiler(s)</i>
[smaɪəɫ]	<i>smile</i>	[smaɪɪŋ], [smaɪəɫɪŋ]		
[vaɪəɫ]	<i>vile</i>	[vaɪəɫəɫ], [vaɪəɫəɫəɫ]		
[maɪəɫ]	<i>mile</i>		[maɪəɫɔɫ], *[maɪəɫəɫɔɫ]	<i>mileage</i>
[naɪəɫ]	<i>Nile</i>		[naɪəɫɔɫk], *[naɪəɫəɫɔɫk]	<i>Nilotic</i>
[kəmpaɪəɫ]	<i>compile</i>	[kəmpaɪɪŋ], [kəmpaɪəɫɪŋ]	[kəmpaɪəɫə], *[kəmpaɪəɫəɫə]	<i>compiler</i>
[staɪəɫ]	<i>style</i>	[staɪɪŋ], [staɪəɫɪŋ]	[staɪɪst], *[staɪəɫɪst]	<i>stylist</i> ²

A similar example comes from Yiddish, which generally avoids [rn] and [rm] codas by schwa epenthesis (**Albright 2010**): [alarəm] 'alarm', [ʃturən] 'storm', [ʃirəm] 'umbrella', [turəm] 'tower' (**CHAPTER 26: SCHWA**; **CHAPTER 67: VOWEL EPENTHESIS**). When an /rm/ cluster is intervocalic, epenthesis does not normally occur: [alarm-ir-n] 'to alarm', [ʃturm-ɪʃ] 'stormy', [ʃirm-ə] 'screen', [turm-ə] 'prison'. This pattern is disrupted in verbal paradigms, however: (5a) shows that, if epenthesis applies somewhere within the paradigm, it systematically overapplies in the entire paradigm. This can be compared with (5b), which shows that, if epenthesis is not conditioned anywhere within the paradigm, /rm/ surfaces uniformly faithfully. Overapplication in the verb [ʃturəm-ən] cannot be attributed to the influence of the related noun [ʃturəm], since the verb [alarm-ir-ən] does not show overapplication on the basis of the related noun [alarəm]. In addition, as the examples above show, epenthesis does not overapply in derived forms; additional examples include [varm-əs] 'warm food' and [refɔrm-ir-n] 'to reform'.

(5) *Overapplication of epenthesis in Yiddish*

a. 'storm'	Expected	≠ Actual	b. 'alarm'	Expected	= Actual
INF	ʃtur̩m-ən	ʃtur̩əm-ən	INF	alɑr̩m̩r-ən	alɑr̩m̩r-ən
1SG	ʃtur̩əm	ʃtur̩əm	1SG	alɑr̩m̩r	alɑr̩m̩r
2SG	ʃtur̩əm-st	ʃtur̩əm-st	2SG	alɑr̩m̩r-st	alɑr̩m̩r-st
3SG	ʃtur̩əm-t	ʃtur̩əm-t	3SG	alɑr̩m̩r-t	alɑr̩m̩r-t
1PL	ʃtur̩m-ən	ʃtur̩əm-ən	1PL	alɑr̩m̩r-ən	alɑr̩m̩r-ən
2PL	ʃtur̩əm-t	ʃtur̩əm-t	2PL	alɑr̩m̩r-t	alɑr̩m̩r-t
3PL	ʃtur̩m-ən	ʃtur̩əm-ən	3PL	alɑr̩m̩r-ən	alɑr̩m̩r-ən

In both the English pre-lateral diphthongization and Yiddish epenthesis cases, phonology is blind to inflectional affixes – that is, a coda process applies as if the stem-final consonant is a coda, even if the inflectional affix should bleed epenthesis. It is not always the case that overapplication extends a process from an inner constituent to an outer constituent in this way, however. The Latin [honor] analogy discussed in §1 involved the overapplication of rhotacism, which should normally have occurred only before vowel-initial suffixes (e.g. /hono:s-is/ → [hono:ris]), but came to apply before nominative singular /s/ (or /Ø/) as well: /hono:s-s/ → [honoər].

Another example of application of a process triggered by an inflectional affix is found in certain dialects of Korean (**Han 2002; Kang 2003**). In Korean, coronal obstruents regularly palatalize (**CHAPTER 71: PALATALIZATION**) before a suffix beginning with high front [i]: /os-i/ → [oʃi] 'clothing-NOM', /pat^h-i/ → [patʃ^hi] 'field-NOM'.³ Palatalization does not normally occur before mid front vowels ([pat^h-] 'field-LOC') or high central vowels ([pat^h-] 'field-ACC'). **Han (2002)**, citing data from **Choi (1998)**, observes that in certain dialects of North Gyeongsang Korean (namely, in Sangju, Geumneung, Cheongdo, and Mungyeong), palatalization overapplies:

(6) *Overapplication of palatalization in North Gyeongsang Korean*

/pat ^h / 'field'	Conservative	North Gyeongsang
UNMARKED	pat̩	pat̩
NOM	patʃ ^h -i	patʃ ^h -i
ACC	pat ^h -il	patʃ ^h -il
DAT/LOC	pat ^h -e	patʃ ^h -e

In North Gyeongsang Korean, as in other dialects, the unmarked form obeys coda restrictions that neutralize continuancy and laryngeal contrasts (**CHAPTER 69: FINAL DEVOICING AND FINAL LARYNGEAL NEUTRALIZATION**). The change in North Gyeongsang consists of extending palatalization within noun paradigms, so that it overapplies before mid and central vowels. Unlike Latin or Yiddish, this case involves the overapplication of a process that is triggered by an inflectional affix.

As with Latin, we must ask whether the change could be interpreted instead as a change in the context of palatalization, or as a lexical re-analysis (**CHAPTER 1: UNDERLYING REPRESENTATIONS**). It is easy to demonstrate that the change is not a general expansion of the context for palatalization to include mid and central vowels. **han (2002)** and **kang (2005)** point out that, within verbal and adjectival paradigms, palatalization never affects /t^h-i/ sequences: /kat^h-i/ → [kat^hi], *[katʃ^hi] 'same-MODIFIER'. Thus, there is no evidence that palatalization in the accusative or locative reflects a broader change in the palatalization process itself. It is also important to ask whether the change is simply a re-analysis of the lexical entry to /patʃ/ – indeed, this is precisely what **Kim (2005)** claims. There are several reasons to think that a purely lexical account is not sufficient, however. First, assuming that the leveling in (6) has affected all /t^h-final nouns in the relevant dialects and that speakers would reject new words with [tʃ^h] ~ [t^h] alternations, we need to account not only for the change to the specific lexical items in question, but also for the knowledge that there could be no lexical items of this type – i.e. a morpheme structure condition. **McCarthy (1998)** proposes to analyze such knowledge as a paradigm effect: specifically, speakers know that palatalization must apply before -i, and that it must overapply in the remainder of the paradigm by virtue of output-output faithfulness; therefore, no morpheme with /t^h/ could ever surface as such within its inflectional paradigm. Even more telling, it appears that overapplication of palatalization may be observed even in cases of partial leveling, where speakers continue to treat the noun as /t^h-final in other contexts. **Han (2002)** and **Kang (2005)** discuss a related pattern found in the dialects of Gyeonggi, parts of Chungcheong, and North Jeolla, in which palatalization overapplies only before the accusative marker /ɨ/, while the expected [t^h] surfaces faithfully before locative /-e/ and directive /ɨlo/: unmarked [pat], nominative [patʃ^h-i], accusative [patʃ^h-ɨ], directive [pat^h-ɨro], locative [pat^h-e]. For these dialects, the use of [tʃ^h] in the accusative cannot be straightforwardly attributed to a re-analysis of the final consonant of the noun stem, since it surfaces as [t^h] elsewhere. Instead, **Han (2002)** claims that we are observing a more limited identity effect, in which the accusative comes to match the nominative, but the locative and directional remain identical and distinct from the other case forms. **Kang (2005)** attributes the identity of the locative and directive to the fact that they share locational meanings.

The Korean example shows that overapplication may extend processes that apply in inflected forms (i.e. overapplication is not “blind” to inflectional material). It also illustrates some of the difficulties in establishing a synchronic paradigm effect as opposed to a diachronic re-analysis. Many cases of overapplication that have been documented in the literature are potentially reinterpretable as lexical re-analyses or broadening of phonological processes. In order to demonstrate that a given case truly involves synchronic paradigmatically motivated overapplication, we must be able to show that the process continues to apply as expected elsewhere in the language, that the relevant lexical items have not been re-analyzed, and that the process overapplies just in those cases where paradigmatic identity would result. Similar considerations hold for identity through underapplication and misapplication, to which we now turn.

2.2 Underapplication

Just as in cases of underapplication of phonological processes to maintain reduplicative identity (McCarthy and Prince 1995; CHAPTER 100: REDUPLICATION; CHAPTER 119: REDUPLICATION IN SANSKRIT), it appears that phonological processes may be suppressed within inflectional paradigms in order to achieve identity. An example can be seen in the behavior of Yiddish [rm] clusters. As shown in (5) above, schwa epenthesis overapplies in Yiddish verb paradigms, just in case epenthesis is expected in a suffixed form such as the 1st or 3rd singular. Interestingly, the converse pattern holds in noun paradigms. As shown in (7), noun plurals are sometimes formed by adding a consonant (/–s/), and sometimes by adding a vowel-initial suffix (usually /–ən/). In contrast to verbal paradigms, schwa epenthesis optionally *underapplies* in noun paradigms if it is not licensed in the plural.

(7) Underapplication of epenthesis in Yiddish nouns

	<i>singular</i>		<i>plural</i>	
a.	fturəm ~ *fturm		fturəms	‘storm’
	firəm ~ *firm		firəms	‘umbrella’
	fvorəm ~ *fvorm		fvorəms	‘swarm’
	vorəm ~ *vorm		vorəms	‘worm’
	arəm ~ *arm		arəms	‘arm’
	turəm ~ *turm		turəms	‘tower’
	alarəm ~ *alarm		alarəms	‘alarm’
b.	fərəm ~ <u>fərm</u>		fərmən	‘form’
	?uniforəm ~ <u>unifərm</u>		unifərmən	‘uniform’
	*farəm ~ <u>farm</u>		farmən	‘farm’

A similar example of parallel over- and underapplication comes from Polish diminutives, as discussed by Kraska-Szlenk (1995: 108–114) and Kenstowicz (1996). Many Polish nouns show an alternation between [u] and [ɔ] before word-final voiced non-nasal consonants, with [u] occurring in closed syllables and [ɔ] occurring in open syllables. The morphological context for raising differs depending on the gender of the noun, since different affixes create closed syllables in masculine vs. feminine nouns:

(8) Regular application of o-raising in Polish nouns (Kraska-Szlenk 1995: 108)

	a. /dɔw/	<i>singular</i>	<i>plural</i>		b. /krɔv/	<i>singular</i>	<i>plural</i>
				‘ditch (MASC)’			‘cow (FEM)’
NOM		d <u>u</u> w	dɔwi		NOM	krɔva	krɔvi
GEN		dɔwu	dɔwuf		GEN	krɔvi	kruf
DAT		dɔwovi	dɔwom		DAT	krɔvje	krɔvom
ACC		d <u>u</u> w	dɔwi		ACC	krɔvĕ	krɔvi
INSTR		dɔwem	dɔwami		INSTR	krɔvā	krɔvami
LOC		dɔle	dɔwax		LOC	krɔvje	krɔvax

In diminutive paradigms, raising alternations are suspended. Instead, the vowel that is expected in the nominative singular occurs everywhere. The diminutive suffix is (on the surface) [–ek] word-finally and [–k–] before a vowel, due to the presence of a fleeting yer vowel, indicated in (9) as /E/ (CHAPTER 112: SLAVIC YERS). As a result, diminutives of masculine nouns end in [–ek–Ø] in the nominative singular. Since the suffix begins with a vowel, raising does not apply in the nominative singular, and it correspondingly underapplies in the remainder of the paradigm (9a). Diminutives of feminine nouns, on the other hand, end in [–k–a]. This suffix does condition raising, and raising overapplies in the remainder of the paradigm (9b).

(9) *Under- and overapplication of raising in Polish diminutives*

a. /dɔw-Ek/ 'ditch (MASC)'			b. /krɔv-Ek-a/ 'COW (FEM)'		
	<i>singular</i>	<i>plural</i>		<i>singular</i>	<i>plural</i>
NOM	dɔwek	dɔwki	NOM	krufka	krufki
GEN	dɔwka	dɔwkuf	GEN	krufki	kruvek
DAT	dɔwkovi	dɔwkom	DAT	kruftse	krufkom
ACC	dɔwek	dɔwki	ACC	krufkē	krufki
INSTR	dɔwkjem	dɔwkami	INSTR	krufkǎ	krufkami
LOC	dɔwku	dɔwkax	LOC	kruftse	krufkax

As **McCarthy (2005)** points out (following **Buckley 2001**; **Sanders 2003**), it is not surprising that the distribution of *o*-raising has been disrupted in modern Polish: raising interacts opaquely with final devoicing, it is conditioned by an unusual set of following segments (non-nasal voiced consonants), and it is not generally applied to loanwords or nonce words. Nonetheless, the fact that raising applies normally in the non-diminutive forms of /dɔw/ and /krɔv/ (8) shows that the process is learned in some (perhaps lexically or morphologically restricted) form, and that it continues to apply in the expected contexts. Furthermore, speakers have clearly learned that these particular stems undergo raising, even in the nominative singular of the diminutive. **Kraska-Szlenk (1995)** and **Kenstowicz (1996)** argue that the lack of raising alternations in the paradigms in (9) is best attributed to a paradigm identity constraint, which holds specifically within diminutive paradigms.

2.3 Misapplication

In some cases, a regular phonological process applies in an unexpected fashion (misapplication). **Harris (1973)** argues that certain exceptions to regular stress placement in Spanish can be explained as identity effects, and that recognizing paradigmatic identity as a grammatical force could avoid the need to complicate the statement of stress rules. An example comes from the imperfect indicative forms of Spanish (discussed also by **Burzio 2005**: 65 and **Oltra-Massuet and Arregi 2005**):

(10) *Avoidance of stress alternations in the Spanish imperfect: [terminar] 'finish'*

	<i>expected</i>	<i>actual</i>
1SG IMP INDIC	termi'naba	termi'naba
2SG IMP INDIC	termi'nabas	termi'nabas
3SG IMP INDIC	termi'naba	termi'naba
1PL IMP INDIC	termina'bamos	termi'nabamos
2PL IMP INDIC	termina'bais	termi'nabais
3PL IMP INDIC	termi'naban	termi'naban

The stress pattern as it would have been inherited from Latin is shown in the left column of (10); this expected pattern also reflects a general pattern of penultimate stress that still holds in modern Spanish. The actual stress pattern in [termi'nabamos] is unusual in Spanish, since words with final closed syllables rarely have antepenultimate stress, the sole exceptions being learned words such as *Sócrates* and *Júpiter*, which are felt by speakers to be unusual (**Hochberg 1988**). This unexpected pattern is immediately explained if we look at the stress pattern of the other cells of the imperfect, where stress is penultimate according to the regular principles of Spanish stress assignment.

Harris (1987) provides another example from certain dialects of Spanish, including Chicano Spanish. As (11a) shows, stress in verbs regularly falls on the penult, both in conservative varieties and in Chicano Spanish. Within the present subjunctive paradigm, however, stress alternations have been eliminated, with stress falling on the antepenult in the 1st plural (11b) (see also **Reyes 1974**). Once again, a possible explanation for this subversion of the regular stress pattern is that it maintains identity among inflected forms. Note that this effect holds locally within the present subjunctive, but does not affect the present indicative, nor does it affect non-verbal forms such as [termino] 'end'.

(11) *Avoidance of stress alternations in Chicano Spanish subjunctive:*
[terminar] 'finish'

	<i>Conservative</i>	<i>Chicano</i>
a. 1SG INDIC	ter'mino	ter'mino
2SG INDIC	ter'minas	ter'minas
3SG INDIC	ter'mina	ter'mina
1PL INDIC	termi'namos	termi'namos
2PL INDIC	termi'nais	termi'nais
3PL INDIC	ter'minan	ter'minan
b. 1SG SUBJ	ter'mine	ter'mine
2SG SUBJ	ter'mines	ter'mines
3SG SUBJ	ter'mine	ter'mine
1PL SUBJ	termi'nemos	ter'minemos
2PL SUBJ	termi'neis	—
3PL SUBJ	ter'minen	ter'minen

Kenstowicz (1996) observes a similar effect for certain Russian nouns, in which stress unexpectedly avoids falling on a fleeting yer vowel in the genitive plural (“double retraction”). Like the Spanish cases, this irregular placement of stress serves to avoid stress alternations within the plural paradigm, and may likewise be attributed to a constraint demanding uniform stress.

2.4 Anti-homophony within paradigms

In addition to serving as the domain for identity effects, inflectional paradigms also appear to be the locus of anti-homophony effects, in which phonology applies unexpectedly in order to avoid surface identity of morphologically distinct forms. The scope and treatment of anti-homophony effects is controversial, but we mention here two examples.

The first example comes from **Kenstowicz (2005)**, who discusses the distribution of schwa in medial open syllables in Damascus Arabic (**CHAPTER 124: WORD STRESS IN ARABIC**). Normally in this dialect, unstressed schwas in open syllables are deleted: /səməʕ-ət/ → [səməʕ-ət] ‘heard-3SG FEM SUBJ’. This deletion also occurs in forms that have been cliticized with object markers: both /dʕarb-ət-o/ → [dʕarbto] ‘hit-3SG FEM SUBJ-3SG MASC OBJ’ and /ʃaʕf-ət-o/ → [ʃaʕfto] ‘saw-3SG FEM SUBJ-3SG MASC OBJ’ show deletion of the underlying /ə/ in the 3rd singular feminine subject marker. However, this deletion is systematically blocked in cases where the form in question would become identical with the corresponding masculine form. For example, /ʕallam-t-o/ ‘taught-3SG MASC SUBJ-3SG MASC OBJ’ and /ʕallam-t-o/ ‘taught-3SG FEM SUBJ-3SG MASC OBJ’ are expected to yield surface [ʕalʕamto], with syncope of the stressless schwa. Instead, syncope is blocked in the feminine form ‘she taught him’, and the schwa exceptionally remains and attracts stress: [ʕallaʕmto]. **Kenstowicz (2005)** attributes this unusual stress pattern, which violates the normal principles of stress placement in Damascus Arabic, to an anti-homophony condition that holds between the 3rd singular masculine and feminine forms. Importantly, this condition does not penalize deletion in cases such as [dʕarbto] ‘she hit him’ or [ʃaʕfto] ‘she saw him’, because for these verbs, the 3rd singular masculine forms happen to follow different vocalic templates: [daʕrab-t-o] ‘he hit him’, [ʃuʕt-t-o] ‘he saw him’.

Hall and Scott (2007) discuss another example, involving underapplication in Swabian German. In this dialect, /s/ becomes [ʃ] before a coronal: /pɔst/ → [pɔʃt] ‘mail’. This process underapplies in inflectional paradigms, however: /griəs-t/ → [griəst], *[griəʃt] ‘greet-3sc’. Hall and Scott attribute this underapplication to the influence of inflectionally related forms with [s], such as 1st singular [griəs]. In the 2nd singular, however, the inflectional affix is /-ʃ/. Here, underapplication of /s/ → [ʃ] would yield the illegal form [griəsʃ], which would be expected to assimilate and degeminate. The candidate [griəʃ], which resolves the /sʃ/ cluster in favor of [s], would create paradigmatic identity with 1st singular [griəst], 3rd singular [griəst], etc., but it would be homophonous with the 1st singular. Instead, the actual outcome is [griəʃ], in violation of paradigm uniformity. Hall and Scott argue that this is due to an anti-homophony condition, in which the 2nd singular is required to be distinct from other forms.

In both the Damascus Arabic and the Swabian German examples, the paradigm is the locus of anti-homophony effects, in the sense that homophony between forms that are not paradigmatically related (as in accidentally homophonous verbs) does not trigger unexpected phonology. If this restriction turns out to hold in a broader range of cases, it could serve as an additional source of evidence that paradigms may serve as the domain of grammatical effects.

3 Grammatical mechanisms for deriving paradigm effects

The fact that the regular application of phonological processes may be disrupted in order to achieve paradigmatic regularity was often commented on in the earlier literature on generative phonology (see, e.g. **Kiparsky 1972; Harris 1973; Kenstowicz and Kisseberth 1977: 69-74**). However, no formal mechanism was provided for accomplishing this effect within the rule-based approach of **Chomsky and Halle (1968; henceforth SPE)**. Indeed, it is hard to see what a mechanism

that explicitly enforces paradigmatic identity would look like, since the decision about whether to apply a rule or not (or to reverse the order of two rules) can be made only by “looking ahead” and seeing whether the results would create alternations within the paradigm. Instead, inflectional identity has often been analyzed as a by-product of how morphological and phonological operations are ordered, under the hypothesis that inflectional affixes are added after many phonological processes have already applied. (See **Downing et al. 2005a** for a review of alternative rule-based mechanisms, and §3.3 below for discussion of cyclic approaches employing phase-based spell-out; see also **CHAPTER 85**: CYCLICITY and **CHAPTER 74**: RULE ORDERING.)

For example, the American English pre-lateral diphthongization data in (4) ([spɔɪət] *spoil*, [spɔɪətɪn] *spoiling* vs. [spɔɪətɔ̃] *spoilage*) can be seen as the result of diphthongization applying after derivational affixes like *-age* have been added, but before inflectional affixes have been added. A challenge for such approaches is to establish an internally consistent ordering of morphological and phonological operations. This is not always trivial; for example, in the author's idiolect, the fact that /l/ is at least optionally dark in words like [spɔɪətɔ̃] *spoilage* and [maɪətɔ̃] *mileage* suggests that velarization is ordered before affixation of *-age*, yet there is no option for dark [ɫ] in words like [saɪləɔ̃] *[saɪləɔ̃] *silage*, which arguably also contains an /l/ before the *-age* suffix. Accounts based on cyclic ordering have no direct way of referring to the fact that for *spoilage* and *mileage*, related forms such as [spɔɪət] *spoil* and [maɪət] *mile* contain dark [ɫ], while for *silage*, the related form [saɪlə] *silo* has light [l].

Paradigm effects of this sort are readily accommodated within Optimality Theory (OT), since evaluation in this framework is carried out over surface forms, which is precisely where identity and contrast must be enforced. In this section, we review the main approaches to enforcing identity among paradigms of inflected forms in OT.

Most approaches to paradigm effects in OT employ correspondence constraints (**McCarthy and Prince 1995**), which place morphologically related forms into correspondence with one another, so that identity can be evaluated with the standard machinery of faithfulness constraints (IDENT, MAX, DEP; see also **CHAPTER 63**: MARKEDNESS AND FAITHFULNESS CONSTRAINTS). Under this approach, paradigmatic identity effects are closely related to cyclicity effects, in which derived forms show unexpected similarity to their bases of derivation. Correspondence relations are intrinsically pairwise, so paradigm uniformity is typically enforced by requiring that each individual pair of forms be identical. Thus, in a sense, paradigm constraints are not truly “paradigmatic,” since they evaluate sets of pairs rather than the entire distribution at once. A cost of this approach, however, is that the number of pairwise relations that must be considered grows factorially with the size of the paradigm – e.g. $6 \times 5 = 30$ pairwise relations for a six-member paradigm.

Since their introduction, correspondence constraints have been used to analyze the relation between derived forms and their bases in producing cyclicity effects (**Burzio 1994**; **Kenstowicz 1996**; **Benua 1997**; **Kager 2000**; **Steriade 2000**). Like input-output faithfulness conditions, base-derivative correspondence is usually assumed to be intrinsically asymmetrical: derived forms must be faithful to their bases, but bases are not constrained to resemble their derivatives (see also **CHAPTER 85**: CYCLICITY). There are two main issues that must be resolved in applying faithfulness conditions to paradigm regularity. First, we must determine whether correspondence relations between inflectionally related forms are intrinsically symmetrical, as is generally assumed for base-reduplicant faithfulness (**McCarthy and Prince 1995**), or asymmetrical, as is usually assumed for other cases of base-derivative faithfulness (**Benua 1997**). Second, if inflected forms are faithful to a base form, we must determine which form acts as the base in an inflectional paradigm.

In this section, the predictions of a symmetrical approach to paradigm uniformity (**McCarthy's 2005** Optimal Paradigms approach) are compared to those of an asymmetrical/base-prioritizing approach (**Albright 2002**; **Kenstowicz 1996**; **Benua 1997**), as well as to a stratal approach in which outputs are evaluated cyclically with interleaved levels of affixation and phonological evaluation (**Kiparsky 1982, 2000**).

3.1 Symmetrical output-output faithfulness: Optimal paradigms

One approach to enforcing paradigmatic regularity is through symmetrical correspondence relations, which simply demand that all inflected forms have identical forms of the root. This symmetrical identity requirement has gone under various names in the literature, including *consistency* (**Burzio 1994, 2005**; see also **CHAPTER 88**: DERIVED ENVIRONMENT EFFECTS), *uniform exponence* (**Kenstowicz 1996**), *paradigm uniformity* (**Steriade 2000**), and, most recently, *optimal paradigms* (**McCarthy 2005**). **McCarthy (2005: 172)** succinctly sums up the motivation for adopting a symmetrical approach to identity in paradigms: “Inflectional paradigms have no base ...: Latin *amat* ‘he loves’ is not derived from *amō* ‘I love’ or vice versa; rather, both are derived from the lexeme /am-/.” The claim that inflected forms are based on a common lexeme but not on each other rests on a morphological notion of *base of affixation*, in which affixation realizes (or marks) morphological features, and affixed forms contain a superset of the morphological information that their inner constituents contain. Under this definition, the base must necessarily contain a subset of the morphological features of derived forms. Depending on the morphological features that one assumes, it is implausible to suppose that the 1st singular “contains” the 3rd singular (though for feature systems that make use of underspecification, see **Harley and Ritter 2002**; **McGinnis 2005**). A similar point is made by **Kager (1999: 282)**, who refrains from positing a relation between the 1st singular and the 2nd plural, since neither one appears to compositionally contain the other.

Because no individual form has priority in a symmetrical approach, paradigms must be evaluated as a set, in case a high-ranking constraint demands a modification in one form that would then overapply in the rest of the paradigm. In

McCarthy's (2005) Optimal Paradigms (OP) formulation, candidates consist of entire paradigms. The stem in each cell in the paradigm stands in correspondence to the stem in every other cell, and output-output faithfulness constraints (OP-IDENT, OP-MAX, OP-DEP) evaluate every pair of surface forms in the paradigm. Paradigm uniformity effects arise when OP-faithfulness outranks the relevant IO-faithfulness constraint. This is illustrated in (12) for the overapplication of schwa epenthesis in Yiddish, discussed in (5) above.

(12) *Optimal Paradigms analysis of overapplication of schwa epenthesis in Yiddish*

/ʃturm, ʃturm-t, ʃturm-ən/	OP-DEP	*rm]	IO-DEP
a. ʃturm, ʃturmt, ʃturmən		*!*	
b. ʃturəm, ʃturəmt, ʃturmən	*!*		**
c. ʃturəm, ʃturəmt, ʃturəmən			***

The tableau in (12) illustrates several important features of the OP approach. The ranking of *rm] over IO-DEP reflects the fact that there is a general process of epenthesis to repair rm] codas. If this ranking did not hold, there would be no possibility of alternations. With this ranking in place, it is possible to rank OP-DEP high, in order to favor an invariant paradigm with overapplication (candidate (12c)), or low, in order to favor normal application (candidate (12b)). Crucially, the only rankings that favor candidate (12a) (underapplication) are those in which IO-DEP outranks *rm] – but these are incompatible with the fact that the language generally has a process of epenthesis. Thus, there is no ranking in which epenthesis is found in general, but underapplies in order to maintain paradigm uniformity. McCarthy dubs this prediction *overapplication-only*. Furthermore, the relative number of intervocalic vs. coda /rm/ sequences in the paradigm cannot affect the outcome, since the logic of strict domination dictates that even one instance of coda /rm/ may be fixed by any number of IO-DEP violations. Thus even if we had considered a paradigm with only a single input like /ʃturm/ and many inputs like /ʃturm-ən/, overapplication of epenthesis would still be the optimal way to satisfy OP-DEP.

On the face of it, the overapplication-only prediction of OP is too strong, since, as we saw in §2.2, paradigm identity may also be achieved through under-application – in fact, the very same process of epenthesis underapplies in Yiddish nouns. The only mechanism available to handle such cases in the OP framework is to find some higher-ranked constraint that would be violated by overapplication. As a hypothetical example of what such a constraint might be, suppose Yiddish were to borrow the English word *platform*, retaining initial stress and creating an associated plural ['platfɔrəm]. In this case, overapplication of schwa epenthesis would yield a plural form with pre-antepenultimate stress and a long stress lapse: ['platfɔrəm] ~ ['platfɔrəmən]. As it turns out, Yiddish stress, though somewhat unpredictable, must fall within the last three syllables of the word (see **Jacobs 2005**: 135–140), so the output ['platfɔrəmən] would be illegal. In this hypothetical example, we could analyze underapplication of epenthesis (['platfɔrəm] ~ ['platfɔrəmən]) as overapplication of lapse avoidance (['platfɔrəm] ~ *['platfɔrəmən]), consistent with the overapplication-only prediction.

(13) *Underapplication as overapplication of an orthogonal process (hypothetical)*

/platfɔrəm, platfɔrəm-ən/	OP-DEP	OP-IDENT (stress)	STRESS	IO-IDENT (stress)	*rm]	IO-DEP
a. 'platfɔrəm, 'platfɔrəmən					*	
b. 'platfɔrəm, 'platfɔrəmən	*!*					**
c. 'platfɔrəm, 'platfɔrəmən			*!			***
d. 'platfɔrəm, plat'fɔrəmən		*!*		*		
e. plat'fɔrəm, plat'fɔrəmən				*!*		

Unfortunately, in the actual cases of underapplication in Yiddish nouns in (7b), it is not clear what such a constraint would be. In particular, the contrasting pair [vɔrəm] 'worm' vs. [fɔrəm] 'form' do not appear to differ in any relevant way that could be capitalized on in order to block epenthesis in the latter case by means of a higher-ranked markedness constraint.

A similar point can be made about the Polish diminutive example in (9). Here, the cases in which raising underapplies in the masculine find exact counterparts in which raising applies normally in the feminine: e.g. accusative plural [dɔwek] 'little ditches' vs. [krufki] 'little cows'. There is no form in the paradigm of [dɔwek] in which raising would not violate a constraint that is also violated in the paradigm of [krufka]. In particular, hypothetical overapplication of raising in the nominative and accusative singular (*[duwek]) would violate the same constraints that are violated by the attested overapplication of raising in the feminine genitive plural ([kruvek]). As **Kenstowicz (1996)** points out, symmetric faithfulness constraints are equally well satisfied by over- and underapplication, and it is not obvious what additional constraint would break the tie. This problem leads **McCarthy (2005)** to suggest that raising alternations must be lexicalized in this case, reflecting the more

generally unproductive nature of *o*-raising in Polish. As noted in §2, it is often difficult to determine whether an attested case of underapplication represents a synchronic paradigm effect, or whether it is the outcome of a diachronic re-analysis in which the relevant alternation simply no longer applies, even when paradigmatic identity is not at stake. Although it appears that at least some cases of underapplication demand a synchronic analysis, more careful investigation is needed to determine whether they are more appropriately interpreted as diachronic effects rather than as synchronic exceptions to the overapplication-only prediction.

Misapplication can also pose a challenge to the symmetrical faithfulness model. The stress patterns of the Spanish imperfect (10) and (dialectal) present subjunctive (11b) show the otherwise practically non-occurring pattern of antepenultimate stress with a closed final syllable ([termi'nabamos], [ter'minemos]). The candidate in which antepenultimate stress is avoided by placing stress too far to the right in other forms (hypothetical [termina'ba], [termina'bas], [termina'ba], [termina'bamos], [termina'bais], [termina'ban]) would fare much better by the constraint that favors penultimate stress with final heavy syllables. This candidate involves a different dispreferred pattern – namely, forms with stress on final open syllables ([termina'ba]). This stress pattern is somewhat rare, but it occurs in native mono-morphemic words ([a'ki] 'here', [so'fa] 'sofa', [xo'se] 'José', etc.) to a far greater extent than antepenultimate stress in words like *Sócrates*. Moreover, invariant suffixal stress is found in other tenses, including the future ([termina're], [termina'ras], [termina'ra], [termina'remos], [termina'reis], [termina'ran]). Thus it appears that the OP approach would favor a paradigm that avoids the stress violation in (actual) [termi'nabamos] by placing stress one syllable to the right (*[termina'ba], *[termina'bamos]).

3.2 Base-prioritizing output-output faithfulness

An alternative possibility is that faithfulness among inflected forms is exactly parallel to the asymmetrical structure of faithfulness among derived forms. Asymmetrical, base-prioritizing faithfulness has been given various names in the literature, including *base identity* (Kenstowicz 1996) and *transderivational correspondence* (Benua 1997). In an asymmetric approach, dependent forms are constrained to be faithful to a designated base form, but the base form is not constrained to match the rest of the paradigm. Thus, we expect the base form to exhibit normal application of regular phonological processes, while the remaining forms may show over- or underapplication in order to resemble the base. Since surface properties of the base form must be known ahead of time in order to evaluate base-faithfulness violations, base-prioritizing faithfulness requires a form of cyclic, or recursive, evaluation. In the discussion that follows, I follow Benua (1997) in assuming that evaluation proceeds in two steps: first the base is evaluated, and then its dependent forms are evaluated. Although recursive evaluation involves more steps than a single, parallel evaluation, the evaluation of output-output faithfulness requires a fraction of the comparisons that are involved in the full pairwise evaluation of the symmetric approach.

An asymmetric approach provides a natural solution to many of the problems pointed out in the preceding section. In the case of stress in the Spanish imperfect and (dialectal) present subjunctive, the unexpected pattern in [termi'nabamos] 'we ended' can be attributed to faithfulness to other forms in the paradigm, in which stress obeys the usual pattern of penultimate stress. Deferring for a moment the question of what form should be designated as the base in general, let us assume for now that the base of Spanish verb paradigms (or, at least, of the imperfect and subjunctive) is the 3rd singular: [termi'naba]. In the base-prioritizing approach, properties of the base are determined "first" according to the general rankings of markedness and IO-faithfulness, and this pattern is then transferred to related form via base faithfulness, as shown in (14). We assume that Spanish has constraints against final stressed vowels (*'V]) and against antepenultimate stress with final closed syllables (*'σσσ]). We also assume that, although antepenultimate stress is sometimes found on vowel-final words, the default is penultimate stress (Aske 1990; Eddington 2000; Oltra-Massuet and Arregi 2005), and that this is favored by a constraint against final lapse (*'σσσ]), not shown). These are overruled, however, by a constraint demanding faithfulness to the stress pattern of the 3rd singular base. (Following Benua 1997, the tableau for the non-basic 1st plural form is indented to show that the evaluation of BASE-IDENT requires reference to the output of the 3rd singular evaluation.)

(14) *Misapplication in the Spanish imperfect*

/termina-ba-Ø/ 'end-3sc'	*BASE-IDENT(stress)	*'σσσ]	*'V]
a. termi'naba			
b. termina'ba			*

/termina-ba-mos/ 'end-1PL'	*BASE-IDENT(stress)	*'σσσ]	*'V]
a. termi'nabamos		*	
b. termina'bamos	*!		

Base identity also addresses the problem of *o*-raising in Polish diminutives. Again deferring the discussion of what form serves as the base in general, let us assume that the base of Polish noun paradigms is the nominative singular. The evaluations of the masculine and feminine nominative diminutives are shown in parallel for /dɔw-(E)k/ and /krɔv-(E)k-a/ in (15). Since these forms are basic, they vacuously satisfy BASE-IDENT. The constraint RAISE is shorthand for whatever constraint motivates [u] in closed syllables; recall that the paradigms of simple (non-diminutive) [duw] ‘ditch’ and [krɔva] ‘cow’ in (8) show that both of these stems participate in raising. For brevity, the constraints that are responsible for the vocalism of the diminutive suffix are not shown.

(15) *Normal application of Polish raising in nominative singular base forms*

/dɔw-Ek-Ø/ 'ditch-DIM-NOM SG'	BASE-IDENT[high]	RAISE	IO-IDENT[high]
☞ a. dɔwek			
b. duwek			*

/krɔv-Ek-a/ 'cow-DIM-NOM SG'	BASE-IDENT[high]	RAISE	IO-IDENT[high]
☞ a. krɔfka		*!	
b. krufka			*

The remaining inflected forms are then constrained by BASE-IDENT to preserve the vowel height of the nominative singular, as in (16).

(16) *Over- and underapplication of Polish raising in non-basic forms*

/dɔw-Ek-a/ 'ditch-DIM-GEN SG'	BASE-IDENT[high]	RAISE	IO-IDENT[high]
☞ a. dɔwka		*	
b. duwka	*!		*

/krɔv-Ek-Ø/ 'cow-DIM-GEN PL'	BASE-IDENT[high]	RAISE	IO-IDENT[high]
a. krɔvek	*!		
☞ b. kruvek			*

By hypothesis, BASE-IDENT for inflected forms is a distinct constraint from whatever base-derivative faithfulness constraints may hold of derived forms. This predicts the possibility of different degrees of faithfulness for inflected *vs.* derived forms. As we saw above for Latin, inflected forms may indeed exhibit greater faithfulness than derived forms. A similar point can be made for Yiddish, in which derivationally related forms show schwa alternations: cf. [alarəm] ‘alarm’ ~ [alarm-ir-n] ‘to alarm’, [ʃirəm] ‘shade’ ~ [ʃirm-ə] ‘screen’, [varəm] ‘warm’ ~ [varm-əs] ‘warm food’. What is not explained by this approach, however, is the cross-linguistic tendency for inflected forms to show greater uniformity than derived forms. If inflectional BASE-IDENT and base-derivative faithfulness are separate and independently re-rankable constraints, we predict that some languages may show greater uniformity in derived forms than in inflected forms.

The analysis in (15) and (16) requires that the nominative singular be designated as the base, even though other inflected forms are not necessarily built compositionally from it. For the masculine diminutive [dɔwek], this coincides with the fact that nominative singular is in a substring of the remaining forms. In particular, although the nominative singular differs from the remaining inflected forms in having an [e] in the diminutive suffix, its suffix is -Ø. As a result, the underlying form /dɔw-Ek-Ø/ is a phonological substring of the underlying form of inflected forms like /dɔw-Ek-a/. In many cases, it is sufficient to posit that null-affixed forms (sometimes termed *isolation forms*) serve as the base for overtly affixed inflected forms; see, e.g. **Kurylowicz (1947)**; **Kenstowicz (1996)**; **Hayes (1999)**; **Hall and Scott (2007)**.

The comparison with the Polish feminine diminutive form [krufka] shows that base forms need not always be isolation forms, however. In this noun class, there is an overt nominative singular affix /-a/ that is not contained in other case/number forms. A common intuition is that even if the feminine nominative singular is phonologically marked (in the sense of having an overt affix), it is nonetheless a plausible base form because it represents a morphologically “unmarked” category (in the

sense of serving as a default or unmarked member of an opposition). Analyses that make use of this more general notion of morpho-syntactic markedness are often somewhat vague as to what the criteria are for identifying the morphologically least marked member of a paradigm, but the general consensus appears to be that it is the nominative singular in a Latin or Polish-like nominal paradigm (Kenstowicz 1996; Sturgeon 2003), and the 3rd singular in a verbal paradigm (Kurylowicz 1947; Mańczak 1958).

The idea that the base of a paradigm is a morphologically unmarked form (null affix, or unmarked feature values) is attractive from the point of view of grounding the structure of paradigmatic correspondence in a universal, morphosyntactically motivated representation. There are cases that are difficult to reconcile with this hypothesis, however. The Latin [honor] example discussed in §1.2 is one potential counterexample, since it shows overapplication in the nominative singular on the basis of morphosyntactically more marked case forms (oblique and plural forms). The underapplication of schwa epenthesis in Yiddish noun paradigms is also a counterexample. Recall from (7b) that epenthesis may fail to apply in final [rm] clusters just in case the plural has a vowel-initial suffix: [vɔrəm] ~ [vɔrəm-s] ‘worm-SG/PL’ (with epenthesis) vs. [fɔrm] ~ [fɔrmən] ‘form-SG/PL’ (epenthesis optionally underapplies). This case is readily accounted for if we posit faithfulness to the plural form. This is illustrated in (17) for the variant [fɔrm] ‘form-SG’.

(17) Underapplication of schwa epenthesis in Yiddish nouns

/fɔrm-ən/ ‘form-PL’	BASE-DEP	*[rm]	IO-DEP
a. fɔrmən			
b. fɔrəmən			*

/fɔrm/ ‘form-SG’ Base: [fɔrmən]	BASE-DEP	*[rm]	IO-DEP
a. fɔrm		*	
b. fɔrəm	*!		*

Under this analysis, the fact that epenthesis underapplies in noun paradigms is attributed to faithfulness to the plural, while the fact that epenthesis overapplies in verb paradigms must be attributed to faithfulness to a form in which normal application would favor epenthesis (e.g. 1st singular: Albright 2010). If this is correct, it suggests that the choice of privileged base form may differ by language and by part of speech (see also CHAPTER 102: CATEGORY-SPECIFIC EFFECTS). This conclusion naturally raises a number of questions: how do learners identify bases? Is it possible to predict which form will act as the base in a given part of speech in a given language, or must it be inferred post hoc from unexpected application of regular phonological processes? Are there limits to which form acts as the base? And if the choice of base can vary freely from language to language, why do certain forms such as the ‘unmarked’ nominative singular and 3rd singular so often act as bases?

Albright (2002) proposes that the choice of base in a given language is not arbitrary, but follows from the distribution of contrasts within paradigms (CHAPTER 2: CONTRAST). Specifically, it is hypothesized that learners identify the form that offers the most phonological and morphological information about lexical items. For example, in Yiddish verbs, some inflectional affixes trigger neutralizing phonological processes such as regressive voicing assimilation (/red-st/ → [retst] ‘speak-2SG’), degemination (/red-t/ → [ret] ‘speak-3SG’; /heis-st/ → [heist] ‘call-2SG’) or coalescence of schwas (/blɔnkə-ən/ → [blɔnkən] ‘meander-1PL’) (CHAPTER 80: MERGERS AND NEUTRALIZATION). As it turns out, since the 1st singular suffix is null and Yiddish has relatively few processes that affect final codas, the 1st singular frequently preserves phonological contrasts that are neutralized elsewhere. One process that does occur word-finally (including in the 1st singular) is epenthesis in [rm] clusters, however – and as we have seen, this process overapplies in verb paradigms. For nouns, on the other hand, pluralization involves a high degree of morphological unpredictability, with several competing plural markers and irregular vowel changes to many stems. Thus, the plural often contains morphological information that is neutralized in the singular (Albright 2008b). This correlates with the fact that schwa epenthesis optionally underapplies in the singular if it does not apply in the plural.

Informativeness effects that run counter to markedness can be observed in a number of languages. In Latin, the nominative singular underwent many phonological and morphological neutralizations, including cluster simplification and morphological syncretism, which were not found in oblique forms.⁴ Albright (2005) provides a quantitative comparison of neutralizations affecting Latin noun forms. This analysis reveals that the nominative singular was the least informative form, which correlates with the fact that nominative singular forms were rebuilt in Latin. An even more striking example comes from Korean verbal inflection. In a survey of dialects and acquisition studies, Kang (2006) shows that a large number of phonologically independent alternations have been eliminated across different dialects and varieties of Korean. However, all of these changes have in common the property that they extend the stem form found before a certain suffix, the informal form /-ə ~ a/. Albright and Kang (2009) show that this form is also the most informative, revealing stem-final consonant and vowel

contrasts more clearly than other suffixed forms.

The typological predictions of an information-based approach are less certain. One factor that appears to encourage base status is token frequency (Kuryłowicz 1947; Mańczak 1958). Plausibly, cells in the paradigm with high-token frequency (CHAPTER 90: FREQUENCY EFFECTS) provide more information to learners, since (on average) more lexical items have been encountered in these forms. Albright (2008a) argues that attestation is by itself also an important type of information, which may bias learners to choose more frequent paradigm members as bases. This, in turn, may explain the fact that morphologically unmarked forms tend to be bases, since they often have the highest token frequency (Bybee 1985: ch. 3).

An important prediction of the base-prioritizing faithfulness account is that the choice between over- and underapplication is a straightforward consequence of whether the process applies in the base form or not. The comparison of masculine and feminine diminutives in Polish shows that even within the same language, this may have different consequences for different words. Another prediction is that the same member of the paradigm should act as basic for multiple dimensions of faithfulness. Albright (2008b) shows that for Yiddish nouns, this is true: the plural acts as a privileged base in conditioning underapplication of /r/ → /r̥/ epenthesis, underapplication of final devoicing, and overapplication of open syllable lengthening. Similarly, Latin showed leveling of not only rhotacism alternations, but also vowel length and nominative singular marking (-s > -is: Kiparsky 1998; Albright 2005). Finally, the changes to Korean verb paradigms discussed by Kang (2006) show parallel changes for a large number of logically independent alternations. If this prediction proves true in general, it could provide strong support for an asymmetric approach in which paradigm uniformity extends an independently designated base form.

3.3 Stratal and cyclic approaches

The approaches discussed above rely on correspondence relations between related surface forms to enforce identity. An alternative approach, which denies the existence of paradigms altogether, attributes the phonological similarity of related forms to the fact that they share morphological and syntactic structure, and are thus (by hypothesis) identical at a certain stage in their derivation. For example, the framework of Lexical Phonology (Kiparsky 1982) and its successor, Stratal OT (Kiparsky 2000), assumes that phonological evaluation and affixation are interleaved, so that phonological processes may apply to inner constituents of the word prior to the addition of later affixes. Work in Lexical Phonology (LPM) has explored the implications of this approach for cyclicity effects in derivational morphology; see especially Giegerich (1999) and CHAPTER 85: CYCLICITY for overview and discussion (also CHAPTER 94: LEXICAL PHONOLOGY AND THE LEXICAL SYNDROME). Importantly, it is assumed that inflectional affixes are added in the last level of affixation, and are therefore ignored by all earlier cycles of phonological evaluation. This suggests an analysis of paradigm uniformity effects that is parallel to the stratal analysis of cyclicity effects in derivational morphology: processes apply incorrectly when phonology evaluates a morphological subconstituent that does not yet contain the relevant inflectional affixes. This is sketched in (18) for the overapplication of epenthesis in Yiddish verbs.

(18) *LPM approach to overapplication of schwa epenthesis in Yiddish verbs*

a. *Stem level: Inflectional affixes not present*

/fturm-/	IO-MAX	*rm]	IO-DEP
a. fturm		*!	
☞ b. fturəm			*

b. *Word level: Inflectional affixes added*

/[fturəm]-ən/	IO-MAX	*rm]	IO-DEP
a. fturmən	*!		
☞ b. fturəmən			

Under this approach, the lack of epenthesis in paradigms of verbs such as *alarm-ir-n* 'to alarm' would be attributed to the fact that verbalizing *-ir-* is a stem-level affix, attaching to bound stems and occurring inside other affixes such as *-ist*.

(19) LPM approach to normal application in alarmir

a. Stem level: Derivational -ir- is present

/alarm-ir/	IO-MAX	*rm]	IO-DEP
a. alarmir			
b. alarəmir			*!

b. Word level: Inflectional affixes added

/[alarmir]-ən/	IO-MAX	*rm]	IO-DEP
a. alarmirən			
b. alarəmirən			*!

A closely related approach relies on the syntactic mechanism of derivation by phase (Chomsky 2001) to evaluate successively larger portions of the word (Marvin 2002; Arad 2003; Piggott and Newell 2006; Marantz 2007; Skinner 2008). Under this approach, it is likewise hypothesized that words are built cyclically, and that certain syntactic heads trigger spell-out and phonological evaluation of the structure that has been built thus far. We assume that verbs like [alarmir] ‘alarm’ have a structure [[[alarm]_v]-ir]_v-n] and verbs like [ʃturəmən] ‘storm’ have a structure [[[ʃturm]_v-Ø]_v-ən], with a null verbalizing head. Under the assumption that verbalizing heads trigger spell-out (Marantz 2007) and that the “little v” head is spelled out with (or is at least visible to) its complement, the innermost spell-out domain of [alarmir] consists of /alarm-ir/ (no epenthesis necessary), whereas the inner spell-out domain of [ʃturəmən] consists of /ʃturm-Ø/ (epenthesis expected). Thus derivations similar to those in (18) and (19) would hold in this approach as well.

Stratal and cyclic approaches evaluate morphologically complex words strictly from the inside outwards. Crucially, there is no way for affixes that are not present to influence the outcome of phonology. For this reason, effects such as the underapplication of epenthesis in Yiddish nouns are unexpected, since the outcome for singular forms like [vɔrəm] ‘worm’ vs. [fɔrm] ‘form’ requires reference to the shape of the plural [vɔrəm] vs. [fɔrm-ən]). More generally, any case in which an output-output correspondence account requires reference to a base form that is not an isolation form or substring of the remaining forms poses a potential challenge to cyclic approaches. It remains a question for future research to determine whether such cases have a different synchronic status from the more common cases of “inside → out” directionality of cyclic influence.

4 Defining and constraining paradigms

Up to this point, we have been intentionally vague as to what forms count as belonging to a single paradigm, relying on an intuition notion of sets of forms that share a root, and in some cases also a set of inflectional features (e.g. imperfect indicative or present subjunctive). One possibility that cannot be immediately discarded is that output-output correspondence relations are established along many dimensions of shared inflectional features (imperfect forms, 3rd singular forms, subjunctive forms, etc.). This unstructured notion of paradigmatic relations appears to miss some general tendencies, however. In point of fact, paradigmatic similarity appears to hold much more strongly within certain sets of forms, such as the set of person/number forms in a given tense and mood. In this section, we briefly review some of the major tendencies that have been identified in the literature, and consider where these tendencies may come from.

The examples in the preceding sections show several recurring patterns. For example, person and number inflections of a verb are often constrained to resemble each other within a given tense, while alternations are tolerated across tenses – e.g. Spanish 1st singular present [ter'mino] ~ 1st singular imperfect [termi'naba]; 1st plural [termi'naban]. Although I know of no comprehensive survey of synchronic paradigmatic effects across different inflectional categories, similar tendencies can be observed in the degree of tolerance for morphologized stem changes across different categories. In a survey of 50 genetically unrelated languages, Bybee (1985) confirms that morphophonological stem changes are virtually never associated with person distinctions, and rarely with number distinctions. Tense and mood, on the other hand, are sometimes accompanied by stem changes, and aspect often is (see also Veselinova 2006 for discussion). These tendencies diagnose a paradigm structure in which certain inflectional features (aspect, and secondarily tense and mood) define rather cohesive paradigms, whereas person and number do not. We must interpret Bybee's findings cautiously, since they admit two possible explanations: perhaps sharing an aspect or tense feature is particularly important in conditioning paradigmatic cohesion, or perhaps differences in tense or aspect are preferentially marked with phonologically salient differences (Wurzel 1989). To the extent that tendencies in morphophonological stem changes are correlated with tendencies in phonological over- and underapplication, we find support for an interpretation in terms of paradigmatic cohesion.

Among nouns, it appears that the domain of phonological misapplication is more likely to be a number subparadigm (e.g. singular or plural) than a case sub-paradigm (e.g. all accusative forms). This appears to be mirrored by the fact that number suppletion is more common than case suppletion (though see Corbett 2007 for discussion). Similar tendencies are also found in cases of diachronic paradigm leveling.

Bybee (1985: 13) interprets these differences in terms of what she calls the *relevance* of different features to the stem. Relevance is defined as the degree to which a given inflectional category changes the meaning of the lexical root – for example, changes in valence, particularly between intransitive and transitive, tend to change the verbal action in a way that changes in person do not. Bybee argues that morphological features that are more relevant are more likely to be marked with overt morphological markers, and are more likely to be accompanied by stem changes. Restated in terms of paradigmatic identity, it appears that the less salient the meaning difference between two forms, the less likely speakers are to tolerate alternations.

Another tendency that can be observed in the examples above is that identity is more strongly enforced among some paradigms than others. For example, Spanish verbs have stress alternations within the present indicative (1_{SG} [ter'mino] ~ 1_{PL} [termi'namos]), but more “remote” tenses, such as the imperfect, lack alternations (1_{SG} [termi'naba]; 1_{PL} [termi'nabamos]). In Polish, raising alternations are observed within the case/number forms of simple nouns (8), but are suspended within the diminutive forms (9). This suggests that paradigmatic identity is not only enforced more strongly for some dimensions (e.g. person/number) than others (e.g. tense), but it is also enforced more strongly in some morphosyntactic contexts (e.g. the imperfect or the subjunctive) than others.

One attempt to derive these tendencies in a formal system is **Burzio's (2005)** Representational Entailments Hypothesis (see also **CHAPTER 88: DERIVED ENVIRONMENT EFFECTS**). Burzio proposes that the strength of the identity condition that holds between two related forms should depend on the degree to which they already have shared meaning, morphology, and phonology. According to this hypothesis, linguistic representations of different items are lined up, and the more material they share, the greater the expectation that they are alike in other respects as well. For example, suppose a given item has feature values [+F, +G, +H, +I]. This can be restated as a set of associations between co-occurring features: [+F] ⇒ [+G], [+F] ⇒ [+H], [+F] ⇒ [+I], and so on. Now suppose we are given another item with feature values [+F, +G, -H, -I]. This item shares the association of [+F] ⇒ [+G], but differs in its other associations – for example, [+F] ⇒ [+I] and [+G] ⇒ [+I] are not met in this form. Finally, compare a third item [+F, +G, +H, -I]. In this form, three entailments concerning [+I] are not met: [+F] ⇒ [+I], [+G] ⇒ [+I], [+H] ⇒ [+I]. In other words, the amount of overlap between [+F, +G, +H, +I] and [+F, +G, +H, -I] makes their difference in [+I] more salient or surprising. Burzio proposes that families of output–output faithfulness constraints are ranked to reflect such differences in overlap: OO-IDENT([+I]) (+F,+G,+H ⇒ +I) >> OO-IDENT([+I]) (+F,+G ⇒ +I). Entailments may be stated in terms of shared semantic or morphosyntactic features, or in terms of shared phonological features.

The Representational Entailments Hypothesis is useful in accounting for why some paradigms are more cohesive than others. For example, in Spanish, the imperfect is marked with an overt marker (*-ba-*) whereas the present tense has no overt tense marker. Therefore, imperfect forms share more properties in common (namely, the property of containing *-ba-*), which may in turn beget additional identity. The present subjunctive does not have an overt marker that makes subjunctive forms more similar to each other than indicative forms, but it is not unreasonable to suppose that the semantic or morphosyntactic representation of subjunctive involves more structure than the indicative does. If such explanations are on the right track, then it should be possible to correlate the degree of structural overlap between two forms and the pressure for paradigmatic identity between them. Crucially, it is possible to infer the structure of the representation of a given inflectional category through independent means (observing overt marking, finding implicational relations and default values, etc.; **Bybee 1985; Harley and Ritter 2002; McGinnis 2005**). Therefore, if the Representational Entailments Hypothesis is correct, it should be possible to predict the strength of paradigmatic identity effects.

5 Conclusion

Kenstowicz and Kisseberth (1977: 74) proclaimed that “... the notion ‘paradigm’ will have to be much more rigorously defined in order for the appeal to paradigm regularity to have much explanatory force.” As this discussion has made clear, more than three decades later we are still in the early stages of understanding what determines the strength of paradigmatic effects, and what this might tell us about the underlying structure of correspondence among inflected forms. The growing literature on paradigm uniformity effects in the past 10 years has made progress on a number of issues, however. First, it has demonstrated that identity among inflectionally related forms is not just a diachronic phenomenon, but can be seen as a synchronic effect in the “wrong application” of productive phonological processes. Furthermore, formalized grammatical approaches to paradigm uniformity make testably different predictions about possible uniformity effects, pointing the way to those cases which deserve the closest empirical scrutiny. Finally, comparison of the cases discussed so far in the literature suggests a number of cross-linguistic trends that must be accounted for in a theory of how phonology refers to morphological structure. A deeper understanding of these tendencies will require a more comprehensive survey of synchronic paradigmatic effects, in order to understand how best to represent – and perhaps also derive – the observed tendencies concerning when paradigmatic identity is enforced.

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Notes

- 1 An alternative view, put forward by **Joesten (1931)** and discussed by **Dammers *et al.* (1988)**: 449) and by **Hartweg and Wegera (1989)**: 129), holds that the distribution in (1) is etymologically expected for all of these verbs, including *geben*, and that the use of 1st singular *gibe* in literary Middle High German represents a partial leveling of the vowel from the 2nd and 3rd singular to the 1st singular in certain dialects. Either way, the difference between dialects with 1st singular *gibe* and those with *gebe* requires some form of analogical change within the paradigm to match a pattern found in other verbs.
- 2 A possible exception is [ˈstai̯əˌʔaɪz] *stylize*. It appears that stress clash avoidance may also play a role in conditioning [əʔ] in this form, however, since the derived noun form is [ˌstai̯əˌʔzeɪ̯fən] ʔ[ˌstai̯əˌʔzeɪ̯fən] *stylization*.
- 3 There is some variability regarding the place of articulation of affricates, ranging from alveolar to post-alveolar or perhaps even palatal; see **Cho (1967)**; **Kim–Renaud (1974)**; **Ahn (1998)**; **Kim (1999)**; **Sohn (1999)**.
- 4 The importance of oblique forms in identifying phonological and inflectional properties of Latin nouns can be seen from the fact that dictionaries typically list an oblique form (the genitive singular) alongside the nominative.

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