Abstract

Dissertation Title:	DISENTANGLING MORPHOSYNTAX FROM MORPHOPHONOLOGY: A RE-EVALUATION OF MORPHOLOGICAL PRIMING
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The notion of morpheme as the smallest unit of form with a meaning has been widely abandoned by theoretical morphologists due to its empirical inadequacy (Matthews 1972, Anderson 1992, Aronoff 1993, Hall and Marantz 1993, Aronoff and Sims 2023). Instead, contemporary approaches to morphology argue for the distinction between morphosyntactic features (e.g., plural) and their phonological realisation (e.g., /-z/ in regular plurals, /-ən/ as in *oxen*, /-ə/ as in *bacteria* or ∅ in *fish)*. However, theories of morphological processing in comprehension and production still widely adopt the notion of morpheme. In this dissertation, I build on the received wisdom in current morphological theorising to address the question of distinguishing morphosyntax and morphonology experimentally. In a series of auditory, continuous lexical decision priming experiments in Hebrew and Italian, I provide

evidence that morphosyntactic features can be primed independently of (morpho)phonological similarity.

DISENTANGLING MORPHOSYNTAX FROM MORPHONOLOGY: A RE-EVALUATION OF MORPHOLOGICAL PRIMING

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Egoque ipse multa quae nesciebam scribendo me didicisse confitear.

Augustine of Hippo, De Trinitate, Book III, Chapter 1

'I must also acknowledge, incidentally, that by writing I have myself learned much that I did not know.'
(tr. Edmund Hill)

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It's the end of July somewhere in Abruzzo and, instead of being intolerably hot, it is a grey day with a cool breeze, of the kind you appreciate only when you know how unbearable it would be under other conditions. The song of the cicadas though is as strong as on any summer day. This is how life feels like at end of this PhD: everything is like it used to be, and yet, also, so completely different. The next few pages are not enough to explain the deep gratitude I have for all those that have supported me in this journey, not only through the normal struggles of graduate life as an international student, but also through a pandemic, and some quite eventful years, of the kind we will tell our grandchildren about.

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Chapter 1

Introduction

'The worth and validity of any experiment are determined by the suitability of the materials as well as by their effective application. In this case as well it cannot be unimportant which plant species are chosen for the experiment or the manner in which it is conducted.'

Gregor Mendel (Scott and Fairbanks 2016)

1.1 Linguistics and psycholinguistics

Picture mid-to-late 19th century. A war is happening basically everywhere in the world: European nations are killing and pillaging in Africa, China is plagued by the Opium wars, the US is torn apart by a fratricidal war fought in the hope of a future where every human being is born free. Now picture a middle-aged Augustinian friar, tucked away in a friary in Brno.[1] While the world goes about its

[1] Fun fact for the history nerds: the newly elected pope, Leo XIV, is also an Augustinian friar.

senseless business, Gregor Mendel is busy growing peas. Year after year, he records the shape and colour of flowers and seeds, and draws generalisations from what he sees. He doesn't know anything about genes or DNA or how exactly it is that traits are transmitted from one generation to the next, but he knows a rule of nature when he sees one. And he stubbornly perseveres in his search for order and beauty in the natural world. His observations, while not 100% correct, will prove extremely valuable for generations of biologists to come, and guide subsequent thinking about genetic traits. It will take almost a century until Franklin, Watson and Crick determine how DNA is structured, but the (physical and intellectual) seeds sown by Mendel during those years turn out to have far reaching consequences for the field of genetics.

Linguistics is not unlike biology. Linguists, all the way from Pāṇini to your favourite contemporary linguist, have been growing (metaphorical) peas for centuries, if not millennia. Their efforts have been repaid by a growing body of knowledge about language, and linguistic representations. While we haven't figured out everything there is to know about linguistic representations and linguistic structure, we are at a point in the history of language science where we can try to attempt what Franklin, Watson and Crick managed to do in the 1950s: asking the *'how'* question. In other words, trying to determine how linguistic knowledge is deployed in real time comprehension and production. That is the job of psycholinguistics. As Chomsky (1965: 9) beautifully puts it:

> 'No doubt, a reasonable model of language use will incorporate, as a basic component, the generative grammar that expresses the speaker-hearer's knowledge of the language but this generative grammar does not, in itself, prescribe the character or functioning of a perceptual model or a model of speech production.'

Let us dwell on this passage for one second more. It is up to psycholinguists to discover 'the character and functioning of a perceptual model or a model of speech production', but to do so we need to 'incorporate, as a basic component, the generative grammar'. In other words, we can't do psycholinguistic work that is not directly informed by formal theories of language. Doing so would be as if Franklin, Watson and Crick had decided to ignore Mendel's or Darwin's seminal work. That would have not only meant to let much valuable research go to waste, but it would also have made their own work very difficult to interpret. The same goes for linguistics and psycholinguistics: formal theories of language are not just wild ideas linguists put forward for their own enjoyment, they are hypotheses about the linguistic knowledge represented in the mind and, thus, should constitute the basis for any theory of psycholinguistics.

It seems clear then that our psycholinguistic experiments should be rooted in linguistic thinking, but given that there are so many different and conflicting theories in formal linguistics, how are we supposed to choose one over the other to propose psycholinguistic experiments? Perhaps the answer is simply that we shouldn't. The times are not yet ripe for us to adjudicate among various linguistic theories, but we can still try to determine what these theories agree on, and what their received wisdom can teach us. Doing so doesn't mean devising a watered-down, hodgepodge version of existing theories that takes bits and pieces from different approaches. On the contrary, it means examining linguistic theories very closely and finding core tenets they agree on, and then basing our experiments on those, being honest that we can't go further than that for the time being. This is precisely the aim of this dissertation: finding an area of linguistic theorising where different formal approaches agree on some core ideas, and devising experiments that align with those. One such area happens to be morphology, to which we now turn.

1.2 Doing away with traditional morphemes

In introductory linguistics classes, we get taught and then, in turn, teach that morphemes are the smallest units of form with meaning. The notion of morphemes was originally devised by American Structuralists to describe the regularities of the languages they were studying. The intuition behind morphemes is simple: it's the idea that we can split words down into smaller pieces and derive their meanings from these pieces. For instance, the word *dogs* can be split into two phonological pieces, namely /dɔg/ and /-z/, which respectively refer to the concept 'dog' and the idea that there is 'more than one' entity involved. Since this idea is so alluringly simple, it soon became a staple of linguistic theory, and was then borrowed into adjacent fields, like psycholinguistics. To this day, the notion of morpheme is more or less explicitly assumed in many psycholinguistic papers (see e.g., Coch et al., 2020 and Kinoshita et al., 2025).

However, when we take a closer look at morphological data crosslinguistically, it becomes clear that morphemes aren't empirically adequate. This is because having unitary morphemes that have a semantic, syntactic and phonological specification can't successfully account for the mismatches we see among these different dimensions of language in actual morphological data. For instance, in English, the morphosyntactic feature plural in English can be realised phonologically in various ways: /-z/ in regular plurals, /-ən/ as in *oxen*, /-ə/ as in *bacteria*. In other words, there isn't a single phonological form corresponding to the meaning 'more than one'. Mismatches on the meaning side of things are also possible: in words like *scissors*, the ending /-z/ doesn't necessarily refer to more than one pair of scissors. Because of mismatches like these, morphologists nowadays maintain that we need to abandon the traditional notion of morphemes, and instead postulate morphosyntactic objects (e.g., the morphosyntactic feature plural) that are distinct from their morphophonological realisations (e.g., /-z/, /-ən/, and /-ə/). Despite substantial disagreements on many other theoretical (and terminological) issues among current theories of morphology, there is fundamental agreement on this point. This gives us a starting place to propose experiments that are informed by linguistic theory without having to adopt any parochial view of morphology.

In practice, then, how do we devise experiments that disentangle morphosyntax from morphophonology? By looking for mismatches between the two, i.e., cases where the same morphosyntactic object is realised by different morphophonological pieces, or vice versa cases where the same phonological material corresponds to different morphosyntactic objects. We do so more specifically by using lexical decision priming experiments which have been the main way to investigate morphological complexity in psycholinguistics. Thus, the concrete 'how' question of this dissertation can be stated as follows: are priming experiments attuned to detect morphosyntactic objects or their morphophonological realisations? We are asking this question not because we are especially interested in priming experiments per se, but because we want to better understand how fine grained a view of morphology they can give us. Indeed, while priming has been widely used to address questions about morphological structure, little is actually known about how it works, and what representations it taps into. The goal of this dissertation is thus to closely investigate which representations priming is sensitive to, in the hope of shedding light on the more general question of how morphosyntactic and morphophonological representations are used in comprehension.[2]

1.3 Novel experimental evidence

In this dissertation, a series of auditory, continuous lexical decision priming experiments were used to address this question. More specifically, mismatches between morphosyntax and morphophonology in Hebrew and Italian were deployed to determine whether priming is attuned to morphosyntactic objects or their morphophonological realisations. In experiment 4.2, I show that two different morphophonological realisations of 1 person plural, namely the prefix *n-* and the suffix *-nu*, prime each other despite sharing only one phonological segment, which is also found in completely different positions in the wordform.

Experiment 5.1 instead looks at allomorphic roots in Italian, whose form changes in different tense/aspect combinations (e.g., *mess* for the past participle and *mett* for most other tenses). In this experiment, I found robust priming between allomorphs of the same root when they also share a prefix and their meaning (*promettere* 'to promise' → *promesso* 'promised'), but only a non-significant facilitation when they don't (*trasmettere* 'to transmit' → *promesso* 'promised'). In other words, no

[2] As well potentially moving away from priming as our primary technique to investigate these questions experimentally.

definitive evidence for pure morphosyntactic priming is found in this experiment, and further experiments should be carried out to determine whether it could be achieved under different conditions.

Finally, in Experiment 6.1, I investigated Italian suffixes, showing morphosyntactic priming over (morpho)phonological identity. Indeed, nominal affixes prime each other whether they are phonologically identical (*giuramento* 'oath' → *allenamenti* 'trainings') or not (*valutazione* 'evaluation' → *allenamenti* 'trainings'), while there is no priming between an adverbial and nominal affix that overlap phonologically (*giustamente* 'rightly' → *allenamenti* 'trainings').

Taken together, these results constitute proof of concept that priming experiments can detect morphosyntactic features. Given that this dissertation is the first work that aims to systematically disentangle morphosyntactic and morphophonological effects of priming, this is initial but compelling evidence that continuous lexical decision priming in the auditory modality can be used to detect morphosyntactic similarity. Indeed, since previous experiments are often ambiguous between being due to morphosyntactic similarity or morphophonological similarity, the experimental evidence provided here sheds new light onto exactly what representations priming is sensitive to. Moreover, they are in line with similar results identified in Goodwin Davies and Embick (2019), where priming is identified between plural nouns (*crimes* → *trees*) but not between words that just share /-z/ as the last segment (*cleanse* → *trees*).

The additional finding of this dissertation is that even large phonological overlap (as in the case of *giustamente* 'rightly' → *allenamenti* 'trainings' in Experiment 6.1) do not lead to priming. These results expand our understanding of phonological priming, especially since it differs from the widely attested facilitatory effects of rhyme prime usually found in the auditory modality (see Dufour, 2008 for an overview). Thus, they spur further questions about under exactly what conditions phonological priming can be identified, and open new experimental possibilities.

The experimental results of this dissertation have far reaching consequences for the field of experimental morphology. First, they invite us to re-evaluate existing experiments as not showing evidence for priming of traditional morphemes, as units of form with a meaning, but instead for priming of morphosyntactic objects, independently of their morphophonological realisation. Secondly, they question our understanding of morphological decomposition as a process of 'morpheme spotting'. It seems more likely that instead what comprehenders are doing is inferring morphosyntax from the surface phonology, in order to get to the correct interpretation of what is being said. Much more work should be done in this respect, but if this intuition is on the right track, it means that understanding how morphosyntactic features are detected in real time has consequences not just for experimental morphology but also for language comprehension more in general. Finally, the results obtained here suggest that priming experiments can also be brought to bear on analytical questions, providing additional evidence on the correct morphosyntactic structure of words that prove difficult to analyse formally. Summarising, while these are just initial results, they open up interesting avenues for the future of experimental morphology, and for a better understanding of how language comprehension works more in general.

1.4 Structure of this dissertation

This dissertation is structured as follows. Chapter 2 provides an in-depth look at five contemporary approaches to morphology, namely A-morphous morphology, Distributed Morphology, Nanosyntax, Spanning and Non-isomorphism.[3] While acknowledging differences among these approaches, I highlight the core commitment that underlies all of them, namely the necessity of distinguishing between morphosyntactic objects and their morphophonological realisations. Chapter 3 re-evaluates existing experimental evidence from lexical decision priming experiments in view of this analytical consensus. The following three chapters provide novel experimental evidence. In these experiments, I use mismatches between morphosyntax and morphophonology to attempt to disentangle them experimentally. In Chapter 4, I look at Hebrew person and agreement affixes, whose morphophonological realisation differs in past and future tenses, and show that there is priming of morphosyntactic features independently of phonological identity. In Chapter 5, I examine a case of root allomorphy in Italian, and show that while there is a numerical tendency towards priming for verbs that share the same morphosyntactic root, this effect is not statistically significant. In Chapter 6, instead, I use a case of accidental homophony between two different affixes in Italian and demonstrate that phonological similarity doesn't engender priming, while shared morphosyntactic structure does. Chapter 7 concludes this dissertation, highlighting how priming is finely attuned to morphosyntactic organisation.

[3] Non-isomorphism is the name I give to a theory of morphology that could be developed from a series of talks and classes by Preminger (2021). See section 2.4.4 for more details.

Chapter 2

Doing away with traditional morphemes

2.1 Introduction

Many psycholinguistic experiments have investigated morphological structure. The debate in the literature has been whether 'morphological' effects can be explained only by assuming the existence of morphemes (e.g., Rastle et al., 2004; Taft, 2004; Taft & Forster, 1975 among many others), or whether they can be explained by direct mappings between meaning and form (e.g., Baayen et al., 2011 among many others). These discussions have been, at least partially, inspired by theories of morphology. Indeed, previous experimental works ascribed to (or aimed to test) specific theories of morphology. Instead, as we have seen in Chapter 1, the approach taken in this dissertation is to look for a common ground among various theories and propose experiments that build on that.

The current understanding in contemporary morphological theorising could be summarised as follows. The traditional notion of 'morphemes', as the smallest units of form with a meaning, is widely regarded as inadequate to account for the variety of morphological phenomena found in the world's languages.[4, 5] Doing away with morphemes does not entail assuming that there is no intermediate representation between meaning and form (*pace* Baayen et al., 2011). Instead, it requires making a distinction between morphosyntactic elements, and morphophonological realisations. Indeed, contemporary approaches to morphology reject the notion that words are created by chaining together morphemes. This is substituted by different mechanisms in different approaches. For instance, in A-morphous Morphology, morphology uses various processes to create lexical items in the lexicon and then to realise morphosyntactic features phonologically.[6] On the other hand, the other approaches reviewed here (namely Distributed Morphology, Nanosyntax, Spanning and Non-isomorphism) argue that morphosyntactic objects are put together in the syntax, and are then realised morphophonologically. The main difference among these latter models is how much syntactic structures they allow to be realised by a morphophonological form.

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[4] Even if I won't go into this, it is worth noting that the rejection of traditional morphemes is not limited to the generative tradition, see e.g. Jackendoff and Audring (2019).

[5] As we will see below, the term 'morpheme' is still used in some current theories of morphology (most widely in Distributed Morphology) but with different, sometimes conflicting, meanings. Thus, I use the phrase 'traditional view of morphemes' as a shorthand for the view of morphemes as the smallest units of form with meaning described in section 2.2.

[6] By 'realise' I mean that a specific morphosyntactic feature is associated with a morphophonological form. For instance, the morphosyntactic feature plural is realised by /-z/ in English. See section 2.4 for a full explanation of morphophonological realisation.

However, despite both the terminological and the more substantial differences among current approaches to morphology, they all argue that a distinction is needed between morphosyntactic objects and the way these are realised morphophonologically. As Aronoff and Sims (2023: 11) eloquently put it:

> '*Criticism of the morpheme as a Saussurean sign culminated in Anderson (1992), after which the definition was abandoned by almost all researchers in favour of a 'morphosyntactic feature realisation' approach. Modern morphologists agree on this general picture. Interestingly, however, differences of terminology obscure what is a fundamental level of agreement on this point* [my emphasis]. At the same time, different understandings of the morphology–syntax interface continue to divide the field in meaningful ways into 'morpheme-based'[7] and 'word-based' approaches, with consequences for the content and structure of the lexicon. In particular, theoretical models differ in the nature of the abstract syntactic representation that the morphology realises'.

These theoretical advancements in analytical morphology can pave the way for new experiments, with designs that explore the difference between morphosyntactic objects and their morphophonological realisations. Experiments of this kind will be pursued in the rest of this dissertation. This chapter, instead, provides an overview of current theories of morphology, highlighting their commonalities, while also acknowledging their differences. Indeed, while there is widespread agreement that we need to separate morphosyntactic objects and their morphophonological realisations, the differences lie in what is considered a morphosyntactic object, how morphosyntactic object are stored and put together, and how they are realised morphophonologically. Thus, the aim of this chapter is to describe in some detail current approaches to morphology, to be able to draw out the commonalities among them. This will allow us, in the rest of this dissertation, to propose experiments that do not adopt

[7] By 'morpheme-based' Aronoff and Sims (2023) mean approaches like Distributed Morphology which, as I have already noted in footnote 5, still use the term 'morpheme' but with a different meaning from the traditional one. See section 2.4.2 for more on this.

a specific theory of morphology, and that instead build on common ground among various theories. While this will require a(n admittedly long) detour into contemporary morphology, it will allow us to stand on firmer theoretical ground and design experiments that go beyond a specific view of morphology.

In a nutshell, this chapter is a primer into what a theory of morphology without traditional morphemes should look like and how we apply it outside the boundaries of morphological theory, and into the realm of psycholinguistics. It is also *not* a middle way solution among conflicting morphological theories,[8] but it is an exercise in ecumenism, looking for unity, even where there isn't uniformity.[9] The need for this exercise is a desire to propose experiments that are informed by current morphological theorising and that, nevertheless, do not strictly subscribe to a specific theory of morphology, and thus can speak to wider issues in the field of morphology.

The chapter is structured as follows. Section 2 traces back the origin of the traditional notion of morphemes to American Structuralists, and explores how a simplified version of it is retained by many of today's scholars, both in psycholinguistics and in linguistics (among non-morphologists). Section 3 describes some of the empirical facts that have led many morphologists to abandon the traditional notion of morphemes. Section 4 explores in some detail five contemporary theories of morphology, namely A-morphous Morphology, Distributed Morphology, Nanosyntax, Spanning and Non-isomorphism. This is not an exhaustive list in any way, but these theories were chosen because they are either widely adopted,

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[8] Among other things, a middle way solution would run afoul of the (strictly necessary, in my opinion) acknowledgement that each of them accounts better for some subset of the empirical data.

[9] I am borrowing the 'unity, not uniformity' principle from Anglican thinking, where it is usually used to refer to the (quite high) degree of freedom in the worship customs that is allowed in the Anglican church. Mark Smith (p.c.) tells me that even if this seems to be a very old concept in Anglicanism, it is difficult to pin down a text that makes this point explicitly.

or because they represent different views on crucial theoretical points. Section 2.5 outlines what the analytical agreement reviewed in this chapter predicts for psycholinguistic experiments, something which will then be explored in more detail in Chapter 3. Section 2.6 concludes the paper.

2.2 What is a morpheme?[10]

The traditional notion of morpheme has its roots in American Structuralism. Indeed, building on Bloomfield (1933), Harris (1942) claims that a morpheme is '[e]very sequence of phonemes which has meaning, and which is not composed of smaller sequences having meaning'.[11] American Structuralists used this definition of morpheme to provide descriptive accounts of the languages they were investigating and tried to refine it over time to acknowledge patterns that didn't fit this definition. However, some of American Structuralists' nuanced understanding of morphemes got lost over time, leaving us with a very simplified notion of morpheme as the 'smallest unit of form with a meaning'. In this section, I provide a brief overview of what is generally assumed by a naive version of the traditional view of morphemes. This is taught in introductory linguistics classes, but is also what is generally assumed in the psycholinguistic literature and even in linguistic works outside of morphology.[12] Bringing out some of the unspoken assumptions that are inherent to the traditional view of morpheme will make

[10] This section owes a lot to discussion of similar themes in Anderson (1992: 9-17 and 48-51).
[11] 'Meaning' in this context is ambiguous here between conceptual meaning (e.g., the form /dɔg/ maps to the concept 'dog'), and morphosyntactic features (e.g., past, plural, etc.). For the time being, we are abstracting away from this, but we will come back to it in section 2.4.
[12] For instance, Coch et al. (2020: 330), state, quoting Moats (2000: 60), that '[a] morpheme is the "most elemental unit of grammatical form that has both sound and meaning"'. Similarly, Kinoshita et al. (2025: 357) claim that '[m]orphemes are form units that are linked to semantic units'. These are just two representative examples of how the traditional notion of morpheme is still assumed in psycholinguistics. Perhaps even more often, psycholinguistic papers assume morphemes without explicitly defining them.

it clearer why such a view, which has nevertheless been so widely adopted, can't successfully account for the morphological facts of the world languages.

The traditional understanding of morphemes views them as the smallest Saussurean signs, made up of a morphophonological form, the signifier, and a meaning, the signified.[13] Let's take a word like *disrespectful* to see how this works in practice. Its meaning is something like 'characterised by disrespect'. Moreover, the meaning of *disrespect* is 'the opposite of respect'. Finally, the meaning of *respect* itself is something like 'regard'. Thus, *disrespectful* can be segmented into phonological pieces as in (1a), whose meanings are shown in (1b). The crucial idea behind separating words into morphemes is that these are pieces of form that carry constant meanings.

(1) a. $[_{A}$ $[_{N}$ dis $[_{N}$ respect]]ful]

b. $[_{A}$ $[_{N}$ OPPOSITE-OF $[_{N}$ REGARD]] CHARACTERISED-BY]

Three different categories of morphemes are usually identified. Roots/stems[14], which carry the main meaning of a word (in the word *disrespectful* the root would be *respect*), derivational morphemes that usually change the lexical category of a root and modify its meaning (*-ful* is a derivational suffix changing a noun into a verb), and inflectional morphemes, which instead provide morphosyntactic features like plural, feminine, past etc. to words (an example of this would be the 3rd person singular

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[13] As shown in Anderson (2019), it was René de Saussure, brother of the more famous Ferdinand, to propose that the smallest unit of meaning is to be found in what will later be called morphemes. Ferdinand, on the other hand, seemed convinced that meanings are associated with words, not morphemes. This brotherly disagreement reflects two divergent views that have been held by morphologists, and that persists to this day, as we will see below.

[14] Here I am using traditional morphological terms like 'root', 'stem' and 'word' in a very loose way. As we will see, among the morphological theories that do away with traditional morphemes, A-morphous morphology retains the notion of word, making it central to its view of morphology, while all the others reviewed here refuse it as empirically inadequate. Throughout this chapter I will slowly build more precise definitions for these terms. See section 2.4 for further terminological notes.

morpheme *-s*). Moreover, morphemes obey some morphosyntactic restrictions. For instance, the derivational suffix *-ful* only attaches to nouns, and the inflectional suffix *-s* only attaches to verbs. Thus, morphosyntactic information is usually (though sometimes implicitly) baked into morphemic representations. Indeed, if we were to visualise morphemes, they would be something along the lines of (2), where a phonological form, /fəl/ is associated with a meaning, 'characterised by N' and a morphosyntactic specification (e.g., this suffix attaches to a noun to create an adjective). However, the morphosyntactic characterisation of morphemes is often disregarded, such that sometimes the representation being assumed is more like (3). Thus, morpheme is often ambiguous between being a triplet of meaning, form and syntax, or just a doublet of meaning and form. As we will see in the next section, either conception is empirically inadequate, but it's good to bear in mind the two possible interpretations of the notion of morpheme.

(2) /fəl/ -'characterised by N' - [Adj __ [N]]

(3) /fəl/ -'characterised by N'

American Structuralists were especially concerned with the surface realisation of morphemes, which can have different forms in different contexts. For instance, the past tense morpheme in English is realised as [t] when the last segment of the stem is a voiceless consonant (*laughed*), [ɪd] when the last segment of the stem is /d/ or /t/ (*wanted*), and as a [d] in all other contexts (*played*, *explored*).[15] Hockett (1947) called these the 'allomorphs' of a morpheme, to parallel the 'allophones' of a phoneme.[16] Thus,

[15] Obviously, past tense in English is not always realised by a regular morpheme. We will come back to this in later sections.
[16] The definition of allomorphy requires that the two allomorphs are the same at some level. Hockett (1947) is aimed precisely at providing principled rules on what morphs should be grouped under the same morpheme. For instance, he argues that all

the traditional view of morphemes usually assumes that words are composed only of (surface realisations of) morphemes,[17] and that morphemes are strictly concatenative, meaning that they are put together one after the other as in a chain.[18] In other words, this view requires affixation, i.e., adding affixes to the left or to the right of the root/stem. Although already Harris (1945) argued for the existence of discontinuous morphemes, i.e., morphemes whose form is interspersed with the form of other morphemes (see section 2.3.1.1 for examples), the concatenative view of morphemes is still widely assumed.

Summarising, a naive version of the traditional view of morphemes commits to the following tenets:

a. morphemes are the smallest units of form, meaning (and morphosyntax),
b. morphemes are realised by different allomorphs in different contexts;
c. words are made up of morphemes,
d. morphemes are concatenated one after the other,
e. the meaning of words is built out of the meanings of its constituent morphemes.

the forms of English plural (i.e., /-z/ in regular plurals, /-ən/ as in *oxen*, /-ə/ as in *bacteria*, etc) should be considered as allomorphs of the morpheme 'noun plural'. Thus, already in such early (and classic) works, the pressing need to differentiate between surface morphs and more abstract morphemes is present.

[17] As Hockett (1947: 331) puts it: 'an utterance consists wholly of morphs'.

[18] *Concatenative* is etymologically related to the Latin word *catena*, meaning 'chain'.

This is what we teach in intro linguistics classes, without giving too much thought to it, and cherry-picking the examples that really work like this for our pedagogical needs. However, the picture is much more complex than this, as we will see in the next section.

2.3 Problems with traditional morphemes

The central tenet of the traditional view of morphemes is that form and meaning always go together in morphemes: in other words, each morphophonological piece in a form corresponds to a meaning/morphosyntactic feature, and each meaning/morphosyntactic feature is carried by a morphophonological piece. However, this biunivocal relationship breaks down more often than not, challenging the very analytical validity of morphemes. Some of these problems were not unknown to Structuralists of the '40s and '50s (e.g., Hockett, 1947 and Hockett, 1987 for a retrospective), and were noticed by various scholars. Anderson (1992: 51-69) constitutes the most systematic critique of traditional morphemes. Here I report both on the problems Anderson (1992) pointed out as well as on additional issues.

Problems with traditional morphemes can be divided into 3 subgroups: problems on the form side of things, problems on the mappings between meaning/morphosyntactic features and form, and problems on the meaning side of things.[19] In order to discuss these issues in as clear a way as possible, I

[19] In some cases, such as for instance for meaningless exponents, the same problem could be described as either a problem for the mapping between meaning and form, or a problem about the meaning. In such cases, I have made an executive decision on where to list the phenomenon in question. This only goes to prove that these issues are all interconnected with one other and really question the validity of the traditional morpheme.

will refer to the morphophonological form of a morpheme as its exponent, and say that an exponent 'realises' a meaning or a morphosyntactic feature. While these terms come, as we will see, from the current morphological thinking, they will make the exposition of the facts much easier and straightforward.

Form wise, we have discontinuous morphemes (infixes, circumfixes and nonconcatenative morphology) as well as morphophonological changes other than affixation (apophony, metathesis, reduplication and subtractive morphemes) which are unexpected under the affixation assumption baked into the traditional notion of morphemes. As far as the mapping between meaning/morphosyntactic feature and form goes, we observe null exponents, portmanteau morphemes (a single exponent corresponding to more than one meaning/morphosyntactic feature), exponents with no meaning (the mirror image of null exponents) as well as cases where the same meaning/morphosyntactic features are realised by different exponents (the mirror image of portmanteau morphemes). We will also look at cases of allomorphy and suppletion among affixes and roots/stems. As far as the meaning is concerned, we find cases where the meaning of a word is not predictable from its constituent morphemes, something that shouldn't happen if only morphemes are the locus of unpredictable meaning (Anderson, 1992: 50).

In a nutshell, we find exceptions to all the statements in (a) and (c-e). We will look at each of these cases more closely, using examples from various languages, and trying to understand how they question the traditional view of morphemes. In all the cases where English provides an example of the phenomenon we want to review, we will use it, even if that example is perhaps not the most compelling that could be found crosslinguistically. This is done mainly to keep this review as accessible as possible to the non-morphologist reader. However, this also makes clear that even in English, the notion of traditional morpheme is empirically inadequate.

2.3.1 Problems with the form of morphemes

2.3.1.1 Discontinuous morphemes

In their original formulation, Structuralist morphemes were strictly concatenative, meaning that they are put together one after the other as in a chain. However, in many languages, we find discontinuous exponents. Under this rubric, we find three different phenomena: infixation, circumfixation and non-concatenative (templatic) morphology. As we have seen in section 2.2, Harris (1945) was already aware of the necessity of allowing for discontinuous morphemes. Thus, while the facts reviewed in this section do require a more sophisticated view of the form of morphemes, they do not constitute a fatal blow to the generally assumed concatenative notion of morphemes (see Bye and Svenonius, 2012 for similar points).

2.3.1.2 Infixes

Infixation is the process through which a phonological exponent is inserted within a pre-existing root/stem.[20] Thus, in infixation, the continuity of the stem is interrupted by the infix. Mlabri, a Mon-Khmer language, uses infix *-rn-* to turn verbs into nouns, as clear from (4).

[20] English doesn't have productive morphological infixes, but the expletive *fuckin'* in English can be inserted as an infix, as in *im-fuckin -portant* (see McCarthy 1982).

(4) a. *guih* 'to ablaze' *g-rn-iuh* 'flames'

b. *kap* 'to sing' *k-rn-ap* 'singing, song'

c. *peelh* 'to sweep the ground/floor' *p-rn-eelh* 'a broom'

d. *tek* 'to hit' *t-rn-ek* 'a hammer'

(Rischel, 1995: 85)

2.3.1.3 Circumfixes

In circumfixation, the affix has two parts, one that attaches to the beginning of the word and one that attaches to the end of it. In a very simplistic way, a circumfix is made up of a prefix and a suffix that always co-occur together. For instance, in Indonesian, abstract nouns can be derived from adjectives by using the circumfix *ke-...-an*, as shown in (5).

(5) a. *baik* 'good' *ke-baik-an* 'goodness, kindness'

b. *bebas* 'free' *ke-bebas-an* 'freedom'

c. *bersih* 'clean' *ke-bersih-an* 'cleanliness'

d. *cantik* 'beautiful' *ke-cantik-an* 'beauty'

e. *sehat* 'healthy' *ke-sehat-an* 'health'

f. *sulit* 'difficult' *ke-sulit-an* 'difficulty'

(Sneddon, 1996:38)

2.3.1.4 Non-concatenative morphology

Non-concatenative morphology refers to morphological systems in which morphemes are not put one after the other (i.e., concatenated as in (1)), but instead are interleaved with one another. Semitic languages are a prime example of non-concatenative morphologies. For instance, the Hebrew root *g-d-l* (whose meaning has to do with 'growing') is interleaved with two different templates, namely *a-a* and *hi-i*, to create two verb forms, as shown in (6).

(6) a. *g-a-d-a-l* '(s/he) grew'
b. *hi-g-d-i-l* '(s/he) enlarged'

(Kastner and Tucker, 2020:10)

Non-concatenative morphology is an extreme case of non-continuous morphology where neither roots or affixes have continuous phonological exponents, and instead they are porous representations that are interspersed with one another. Simply put, non-concatenative morphologies require morphological representations that are non-continuous, and a way to interleave root and affixal exponents with one another.[21] What infixation, circumfixation and non-concatenative morphology have in common is that they differ from more 'well-behaved' prefixation and suffixation in using non-continuous morphemes. We have highlighted these cases here because they require us to think more carefully about the morphological representations we need in order to account for the variety attested in the world's languages, something that often goes unnoticed outside of morphology circles.

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[21] McCarthy (1979, 1981) provides a way of doing this using different tiers for the different exponents in the spirit of Autosegmental Phonology. Another way of thinking about this is that non-concatenative morphologies require representations that specify order, but not adjacency. As I have argued elsewhere (Cuonzo, 2024), a straightforward way of accounting for this is to use phonological graphs (Raimy, 1999, 2000; Papillon, 2020).

2.3.1.5 Morphological changes other than affixation

A more serious challenge to the traditional morpheme comes from cases where we can't identify an affix: in other words, cases where the difference in meaning between two forms is signalled by morphophonological changes other than affixation. Various phenomena can be catalogued under this category: apophony, metathesis, reduplication, and subtractive morphology.

2.3.1.6 Apophony

In apophony, the vowel(s) of a form change in quality between one form and the other. Some of the irregular past tenses in English show this kind of morphophonological change, as shown in (7).

(7) a. *sing* *sang*
b. *blow* *blew*
c. *fly* *flew*
d. *read* *read*
e. *break* *broke*
f. *choose* *chose*
g. *dig* *dug*

As clear from (7), there is a wide variety of changes in vowel quality between the present and past tense verbs in English. These cases are problematic since in none of them there is a constant morphophonological exponent that could identify these forms as past tense verbs.

2.3.1.7 Metathesis

Metathesis occurs when two adjacent segments exchange their respective order. For instance, in Klallam (also known as *nəxʷsƛ̓ay̓əmúcən*), a Salish language of Washington's Olympic Peninsula, the distinction between actual and non-actual is signalled by metathesis in CCV roots. As clear from (8), the order of the consonant and the vowel is exchanged in the two forms.

(8) *čkʷu-t* 'shoot' *čukʷ-t* 'shooting'[22]

(Thompson and Thompson, 1969 cited in Anderson, 1992: 66)

Metathesis doesn't involve any additional affix, and just entails an internal reshuffling of segments.

2.3.1.8 Reduplication

Morphological uses of reduplication are widely attested in the world's languages. For instance, in Indonesian, reduplication signals plurality, as clear from (9).

(9) a. *pulau* 'island' *pulau-pulau* 'islands'
b. *anak* 'child' *anak-anak* 'children'
c. *siswa* 'student' *siswa-siswa 'students'*
d. *kunci 'clue'* *kunci-kunci* 'clues'

(Dalrymple and Mofu, 2012: 229-233)

[22] The function of the actual in Klallam is akin to that of a progressive.

In all these cases, the added material doesn't have a fixed form. Moreover, it is unclear that the meaning of the added exponent is plural: the whole reduplicated form is itself plural, but none of its constituent parts is clearly identifiable as signalling plurality.

2.3.1.9 Subtractive 'morphemes'

The final case we will review in this section is the case of subtractive 'morphemes'. These are cases where the opposite of affixation happens: phonological material is deleted from the original form. While cases of subtractive morphemes are rare in the world's languages, they are nevertheless attested. For instance, in southern varieties of Italian as well as in various southern Italo-Romance languages, the vocative is created by deleting all the phonological material after the stressed syllable. Examples in (10) are from the regional variety of Italian spoken in Abruzzo.[23]

(10) a. *Luigi* 'Luigi' *Luì* 'Luigi.vocative'
b. *Manuela* 'Manuela' *Manué* 'Manuela.vocativeì
c. *Domiziana* 'Domiziana' *Domizià* 'Domiziana.vocative'
d. *Emmanuel* 'Emmanuel' *Emmà* 'Emmanuel.vocative'

In these cases, not only no affix is added, but phonological material is actually subtracted from the base form. Crucially, we have to derive the vocative from the base form and not vice versa, since the deleted

[23] By regional variety of Italian, I do not mean Abruzzese, the local Italo-Romance language spoken in Abruzzo, but instead the dialect of Italian spoken in Abruzzo, whose syntax and phonology are influenced by Abruzzese.

material is not predictable from the vocative. In these cases too, there is no form corresponding to the change in morphosyntactic function of the nouns in question.

2.3.2 Mismatches between form and meaning

Another serious challenge to the traditional view of morpheme is the lack of one-to-one correspondence between morphosyntactic features/meaning and form. Under this rubric, we can find: null exponents, superfluous exponents, portmanteau 'morphemes', double exponence as well as cases of allomorphy and suppletion among affixes and roots/stems.

2.3.2.1 Null exponents

Sometimes we find no phonological exponent where we would expect some. For instance, in English, while regular plurals take the suffix /-z/, some nouns remain the same in the singular and plural forms, as in (11).

(11) a. *fish* (sing.) *fish* (plur.)
b. *sheep* (sing.) *sheep* (plur.)

Similar cases are found in the derivational domain too in English, where some denominal verbs are derived from nouns without any phonological change, as shown in (12), even though there are cases where the derived verb is clearly marked as a verb (as in *energy ~ energise)*.

(12) a. *hammer* (noun) *hammer* (verb)

b. *iron* (noun) *iron* (verb)

One possible way of analysing these cases is by saying that the plural and the verbalizer are realised by a null exponent, such that their structure would be actually something along the lines of (13) and (14).

(13) *fish-∅*
fish-plural

(14) *hammer-∅*
hammer-verb

These cases can be accounted for by the traditional view of morphology if one allows for phonologically null exponents for morphemes. However, they highlight once more that the relationship between meaning and form is not as close as traditionally assumed.

2.3.2.2 Superfluous exponents

Just like we find cases where some meaning or morphosyntactic features are not associated with any morphophonological exponent, we also find mirror-image cases where an exponent doesn't correspond to any meaning. For instance, in Italian, like in all other Romance languages and in Latin, verbs have to have a vowel in between the stem and the infinitival ending, as shown in (15).[24] This is usually referred to as a thematic vowel.

(15) a. *am-a-re*

24 The thematic vowel is found in the majority of tenses, however some irregular verbs lack it in some tenses. We will come back to this in Chapter 5, since Italian irregular verbs will constitute the critical stimuli for an experiment.

love-th.vowel-inf

'to love'

b. *legg-e-re*

read-th.vowel-inf

'to read'

c. *fin-i-re*

stop-th.vowel-inf

'to stop'

These theme vowels are not consistently associated with a single meaning or morphosyntactic feature. Indeed, even if there are some statistical correlations between theme vowel class and some morphosyntactic features or morphophonological behaviours, these are just tendencies. For instance, in (15b), we find an example of a verb in the *-e-* theme vowel class. A subset of the verbs occurring in this conjugation are irregular verbs.[25] In (15c) instead, we find an example of a verb belonging in the *-i-* theme vowel class. A subset of the verbs occurring in this conjugation are inchoative verbs (see Napoli and Vogel, 1990). However, theme vowel class does not strictly predict morphosyntactic or morphophonological behaviour. Moreover, the great majority of verbs belong to the *-a-* conjugation, like the verb in (15a), and no membership criterion can be even loosely associated with this conjugation class (for instance, new and borrowed verbs are assigned to this class). It is also worth noting that the *-e-* conjugation class is associated with morphophonological characteristics of stems (i.e., whether they are

[25] By irregular here I mean that they have irregular past tenses and/or past participles. More on this in Chapter 5 which uses Italian irregular verbs as experimental stimuli.

irregular or not), while the *-i-* conjugation is associated with a specific argument structure. Thus, even if some sort of morphemic story could be told about the subset of inchoative verbs in the *-i-* conjugation, where the theme vowel would potentially be spelling out morphosyntactic features associated with a specific argument structure, no meaning or morphosyntactic feature can be associated with the other conjugation classes. In other words, thematic vowels are exponents carrying no meaning or morphosyntactic feature, and which seem to be present just for some morphotactic requirement that demands a vowel to intervene between the stem and the tense/agreement affixes. Theme vowels are thus a case of morphophonological exponents that are not associated with a meaning or morphosyntactic feature.[26]

2.3.2.3 Portmanteau 'morphemes'

Another mismatch between meaning/morphosyntactic features and form is found in portmanteau 'morphemes'. In these cases, a single form realises multiple morphosyntactic features. For instance, in Italian, the single vowel at the end of the noun indicates both gender and number, as shown in (16).

(16) a. *cas-a* *cas-e*
'house-sing.fem' 'houses-plur.fem'

b. *piatt-o* *piatt-i*

[26] Phenomena like this fall under what Aronoff (1994) would call 'morphology by itself', aspects of morphology that can't be predicted from phonological facts and that have no consequence for the syntax or the meaning.

'plate-sing.masc'　　　　　　'plate-plur.masc'

In these cases, we have a many-to-one mapping from meaning/morphosyntactic features to form.

2.3.2.4 Affix suppletion

In English, the default realisation of the plural is /-z/, but plural can also be realised differently depending on the noun it pluralises, as shown in (17).

(17) a. *ox-en*
 b. *childr-en*
 c. *bacteri-a*
 d. *fish-Ø*[27]

The morphophonological exponents that realise plural are all different from each other. Thus, suppletion differs from allomorphy (which we have seen in section 2.2) in that the exponents in question are phonologically unrelated.[28]

[27] Obviously, whether there is a Ø allomorph will depend on whether the morphologist doing the analysis allows null exponents in their theory or not.

[28] The term 'allomorph' is used to refer to both cases of suppletion, i.e., when the morphophonological exponents involved are phonologically unrelated to one another (such as /-z/, /-ən/, /-ə/ for plural), as well as cases of allomorphy, where the various morphophonological exponents are all derived from a single underlying form (e.g., plural /z/ is realised as [-s] after voiceless consonants and as [ɪz] after affricates and fricatives, and [z] in all other contexts). I too will use the term ambiguously here.

2.3.2.5 Root allomorphy and root suppletion

Cases of allomorphy are found not only in the affixal domain, but also among roots/stem. An example of root allomorphy is found in English past tense verbs where the base forms and the past tense form are phonologically similar to each other, as shown in (18).

(18) a. *sing* *sang*
b. *blow* *blew*
c. *fly* *flew*
d. *creep* *crep-t*
e. *light* *li-t*
f. *catch* *caugh-t*

In these cases, the morphophonological changes from base form to past tense form basically amount to apophony, and optional addition of a suffix. However, the morphophonological differences between different forms of the same root can be more radical. For instance, some Latinate roots in English have very different forms when they occur as verbs and when they occur as nouns, as clear from (19-20).

(19) a. *re-ceive* *re-cept-ion*
b. *de-ceive* *de-cept-ion*

(20) a. *ad-mit* *ad-miss-ion*
b. *per-mit* *per-miss-ion*

When the two forms of a root do not have any phonological content in common, we step out of the realm of allomorphy and into that of suppletion. In English, there are only a handful of cases of root suppletion, as shown in (21).

(21) a. *go* *went*

b. *person* *people*

c. *bad* *worse* *worst*

d. *good* *better* *best*

While root/stem suppletion is not rare crosslinguistically, only very few roots/stems within a language will be suppletive, and they usually are very frequent lexical items (Hippisley et al., 2004). Harley (2014) provides examples from Hiaki, a Uto-Aztecan language spoken in Sonora and Arizona, where there are some 14-15 suppletive verbal roots, and this is probably the upper limit of cases of root suppletion a language can reach.

It is sometimes difficult to draw the line between root allomorphy and root suppletion (for instance, the allomorphic forms *ceive/cept* have only one segment in common, just like *person/people* which is usually considered a suppletion case), and not all analysts even agree that we need to distinguish between them.[29]

[29] Apart from this empirical question, root allomorphy and root suppletion face us with theoretical questions as well: should we treat them as the same or not? There are three logical possibilities in this regard:
i. derive root allomorphy phonologically and root suppletion by storing independent morphophonological exponents;
ii. derive both allomorphy and root suppletion phonologically;
iii. derive both allomorphy and root suppletion by storing independent phonological forms.
All of these analytical options are attested in the literature, showing how much disagreement there is on this issue.

2.3.2.6 Double exponence

We have a case of double exponence when the same meaning or the same morphosyntactic feature is realised by more than one morphophonological change.[30] Above, we have seen that the morphosyntactic feature plural can be realised by the exponent /-ən/. However, in a form like *children*, the addition of the suffix /-ən/ co-occurs with a morphophonological change in the root.[31] While these cases are rare in English, they are found robustly in other languages. As clear from (22-23), verbs where the form of the root doesn't change between the infinitive and the simple past, the exponent for 3rd person plural is *-rono.*

(22) a. *am-a-re*
love-th.vowel-inf
'to love'

b. *am-a-rono*
love-th.vowel-3pl.past
'they loved'

(23) a. *fin-i-re*
finish-th.vowel-inf
'to finish'

b. *fin-i-rono*

[30] Anderson (1992: 55) calls this 'reciprocal conditioning', and gives examples from Icelandic: tek-ur 'you.sg take' and tók-st 'you.sg took'. In these cases, both the form of the stem and that of the agreement suffix change according to tense.
[31] Some morphologists consider the /-t/ at the end of irregular past tense in English as in brought, caught, etc as the exponent of past tense. If that's the case, these too are cases of double exponence.

finish-th.vowel-3pl.past

'they finished'

However, for verbs whose root changes from the infinitive to the past tense, the exponent for 3rd person plural is *-ro.*

(24) a. *legg-e-re*

read-th.vowel-inf

'to read'

b. *less-e-ro*

read.past-th.vowel-3pl.past

'they read'

(25) a. *cogli-e-re*

pick-th.vowel-inf

'to pick'

b. *cols-e-ro*

pick.past-th.vowel-3pl.past

'they picked'

Double exponence is the mirror image of portmanteau morphemes, since a single meaning/morphosyntactic feature is realised by two morphophonological changes.

2.3.3 Problems with the meaning of morphemes

Until now we have seen cases of problems with the form of morphemes, or mismatches between form and meaning/morphosyntactic features. In this section instead, we will look at problems on the meaning side of things.

2.3.3.1 Meaningless exponents

Morphophonological pieces that have no meaning are widely found in the world's languages. For instance, in English many (if not all) names for berries are compound nouns, as shown in (26).

(26) a. *blueberry*

b. *blackberry*

c. *juneberry*

In some cases, however, we find what superficially appear to also be compounds, whose first element is nevertheless meaningless, as in (27).

(27) a. *cranberry*

b. *huckleberry*

In these cases, we are faced with 'morphemes' that have no meaning.

2.3.3.2 Unexpected meanings

The meaning of words can't always be derived from their constituent morphemes. Let's first see an example of where that's possible. If we look at the words in (28), they all have the same root *horr-* and their meanings are related to the idea of something deeply scary or disturbing.

(28) a. *horr-or*

b. *horr-ify*

c. *horr-ify-ing*

d. *horr-if-ic*

We have the noun, *horror*, and the verb *horrify* that means something along the lines of 'engender horror'. We also have two adjectives *horrifying* and *horrific*, both derived from the verb, that mean something along the lines of 'that engenders horror'. So far so good: the meaning of all these words can be derived from the meanings of their morphemes. But now, let's look at the examples in (29).

(29) a. *terr-or*

b. *terr-ify*

c. *terr-ify-ing*

d. *terr-if-ic*

The root *terr-* has a very similar meaning to that of *horr-*, having to do with intense fear. *Terror*, *terrify* and *terrifying* all behave like their counterparts in (28), but *terrific* does not. Quite unexpectedly, it means something along the lines of 'amazing', despite containing the root *terr-*.[32] Cases like this are actually more widespread than one could think initially. A few examples are provided in (30).

(30) a. *head-y* ≠ 'related to the head'

b. *brain-y* ≠ 'related to the brain'

c. *pro-tect-ion-ism* ≠ 'something to do with protection'

(Shah, p.c.)

d. *concert-ed* ≠ 'related to concerts'

e. *under-stand* ≠ 'stand under (something)'

f. *jelly-fish* ≠ 'a fish made of jelly'[33]

g. *curate* ≠ 'a verb related to cure'

An especially interesting case is constituted by Latinate roots in English. As we have seen in section 2.3.2.5, we think that the following verbs have a root/stem in common because they undergo the same morphophonological changes, as clear from (31-32).

(31) a. *re-ceive*	*re-cept-ion*
b. *con-ceive*	*con-cept-ion*
c. *de-ceive*	*de-cept-ion*

(32) a. *ad-mit*	*ad-miss-ion*
b. *com-mit*	*com-miss-ion*
c. *per-mit*	*per-miss-ion*

[32] The *horrific/terrific* examples are from Preminger (2021).

[33] Among compounds, we found very many cases where the meaning of whole words is not compositionally derived from its constituents, see e.g. *silverfish*, *honeymoon*, *eggplant*.

Nevertheless, it is impossible to determine what the meaning of *ceive/cept* or *mit/miss* is supposed to be. Instead, the meaning of each of these forms seems to be calculated over the whole word. In other words, the domain of unpredictable meaning seems to be not the morpheme, but the whole word. Aronoff (1976, 1994, 2007), Anderson (1992) and many other lexicalists with him take this to mean that words, not morphemes, are the domain of unpredictable meaning. What a word is never clearly defined in these works, but there are cases where the meaning of expressions is calculated over what would be considered more than one word. One such case are particle verbs, as shown in (33-34).

(33) a. *go*

b. *go off*

c. *go on*

(34) a. *hang*

b. *hang out*

c. *hang around*

(35) a. *throw*

b. *throw up*

Moreover, in idioms, the domain for unpredictable meaning corresponds to phrases, as shown in (36).

(36) a. *kick the bucket*

b. *spill the beans*

c. *hold your horses*

As we will see in later sections, practitioners of syntactic approaches to morphology take this as an argument against lexicalist theories since it shows that the domain of idiosyncratic meaning can be even bigger than words. As we will see, what the domain of unpredictable meaning is, is a point of hot contention between A-morphous morphology, and the other morphological theories reviewed here. However, there is widespread consensus that the meaning of words can't always be built off of the meanings of its morphemes.

2.3.4 Interim conclusion

In section 2.2, we have seen some of the tenets that (a naive version of) the traditional view of morphemes commits to:

a. morphemes are the smallest units of form, meaning (and morphosyntax),
b. morphemes are realised by different allomorphs in different contexts;
c. words are made up only of morphemes,
d. morphemes are concatenated one after the other,
e. the meaning of words is built out of the meanings of its constituent morphemes.

Let us see how some of the phenomena reviewed until now challenge this view. First of all, there are frequent mismatches between what's the smallest domain of meaning and the smallest domain of form (point a). In words like *cranberry* and *receive*, *cran* and *ceive* seem to behave as morphemes, but do not have any meaning. Moreover, in the world's languages, we also find cases where there are morphophonological pieces that not only do not have any meaning, but also seem to be there just for (morpho)phonological requirements (point c). An example of this is theme vowels in Romance languages. Furthermore, as we have seen, the strictly concatenative view of morphemes is not tenable if we have to account for infixation, circumfixation and templatic morphology (point d). Finally, there are many cases where the meaning of words cannot be derived from the meaning of their morphemes, as shown by words like *understand*, whose meaning has nothing to do with *stand* (point e).

All theories of morphology have to provide an account of how form, meaning and morphosyntactic features are related to each other, and the traditional view of morphemes chooses to do so by having atoms of language, namely morphemes, that contain all of these. However, there are many cases where there is a mismatch between morphophonological pieces, domains of meaning and domains of morphosyntax. That is why the traditional notion of morpheme, despite its appealing simplicity, has been widely abandoned. The next section is dedicated to reviewing some of the alternatives to this view that have been proposed in the literature.

2.4 Current morphological approaches

In this section, we will review five current approaches to morphology, namely A-morphous Morphology, Distributed Morphology (DM), Nanosyntax, Spanning and Non-isomorphism. As already pointed out in section 2.1, this is not an exhaustive list, but these theories were chosen because they are either widely adopted, or because they represent different views on crucial theoretical points. I will highlight how they differ from each other despite starting from similar empirical observations and sharing the realisational stance. Before going into the specifics of each account, it will be useful to have some guiding questions to categorise approaches.

(Q1) What are the basic elements of morphology in this approach?

(Q2) What's the relation between morphology and syntax in this approach?

(Q3) Is this a fully realisational approach?

(Q4) How are meanings derived in this approach?

The questions in (Q1-4) will help us abstract away from the technicalities of each approach, and discern better how they relate to each other.

2.4.1 Some preliminary remarks

Before getting into the details of each analysis, however, we need to clarify a few foundational issues. Indeed, until now, we have been a little sloppy about the distinction between morphosyntax and meaning. This is because, as we have seen in section 2.1, in the traditional definition of morpheme, as as the smallest unit of form with a meaning, 'meaning' is ambiguous between conceptual meaning and morphosyntactic features. Thus, for instance, the root *dog* has the morphophonological form /dɔg/ and the conceptual meaning 'dog'. Instead, the plural morpheme *-s* is made up of the morphophonological form /-z/ and the morphosyntactic feature plural. However, morphosyntactic features are not meanings themselves, and they only map to meanings. Let's take the example of plural. The morphosyntactic feature plural doesn't necessarily mean 'more than one'. For instance, a noun following the numeral *zero* has to be marked as plural in English, as shown in (37).

(37) It is zero degrees outside.

In this case, the morphosyntactic feature plural doesn't correspond to the meaning 'more than one'. Pluralia tantum like *scissors* can refer to a single or multiple pairs of scissors, therefore showing that the morphosyntactic feature plural doesn't necessarily mean 'more than one' in this context. The same can be said about the morphosyntactic feature past, which does not necessarily mean 'occurred in a time before now'.[34] Indeed, morphosyntactic past can be deployed for politeness purposes, as shown in (38).

(38) Did you want milk in your tea?

Similarly, in languages with grammatical gender, morphosyntactic features like masculine and feminine do not necessarily mean 'male' or 'female', as shown by the following Italian examples. In (39), the morphosyntactic feature feminine does mean 'female', but that is not the case in (40).

(39) ragazz-a
youngster-fem
'girl'

(40) penn-a
pen-fem
'pen'

[34] A more formal definition of this meaning would be something like 'the reference time is before the utterance time'.

These examples should clarify that morphosyntactic features are related to, but distinct from meanings. Similarly, morphosyntactic features are distinct from their morphophonological realisation. As we have seen extensively above, the morphosyntactic feature plural is realised as /-z/ for regular nouns, /-ən/ in *oxen*, /-ə/ in *bacteria*.

The insight then is that we need to distinguish between morphosyntactic features from their morphophonological and their meanings, as shown by Figure 2.1. In other words, morphosyntactic features exist independently of the meanings they carry or the morphophonological form that realises them.

Figure 2.1 The distinction between meaning, morphosyntax and morphophonology.

The traditional approach to morphology that we have reviewed in section 2.2 basically groups these three domains under the notion of morpheme, as should be clear from Figure 2.2.

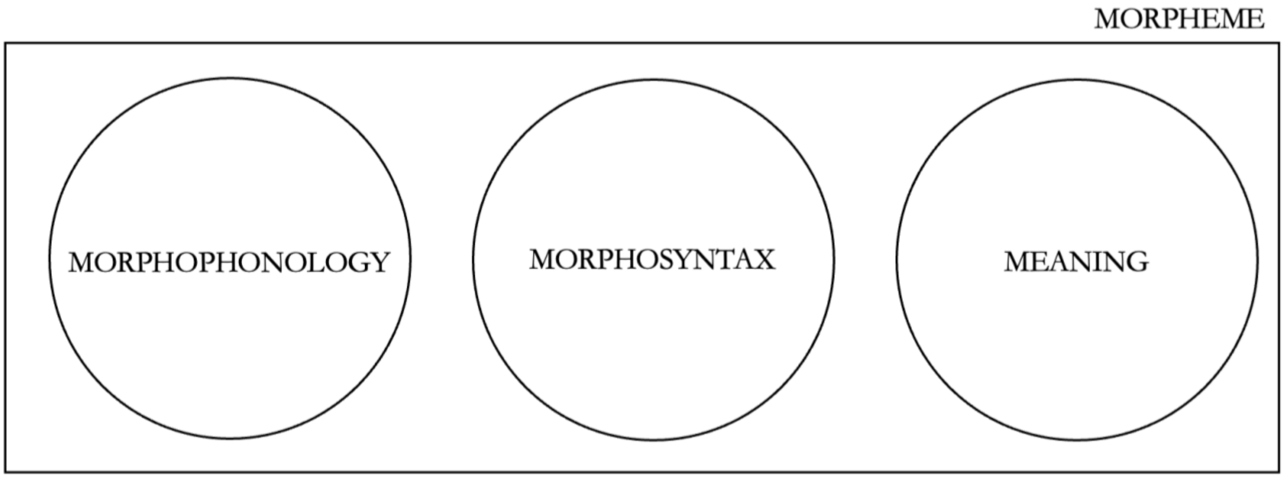


Figure 2.2: Morphemes are characterised by meaning, morphosyntax and morphophonology. [35]

However, there are often mismatches between meaning, morphosyntax and morphophonology, as shown by the empirical phenomena we reviewed in section 2.3. Thus, current approaches to morphology have moved away from morphemes and instead recognise the need to distinguish between different types of representations as well as mismatches among them. While all the approaches to morphology that we will review in this chapter distinguish between morphosyntactic objects and their morphophonological exponents, not all of them overtly distinguish between morphosyntactic objects and their semantic interpretations. In other words, some accounts have distinct representations for meaning, morphosyntax and morphophonology as shown in Figure 2.3, while others conflate semantic and morphosyntactic representations, as in Figure 2.4.[36]

[35] As we have seen in section 2.2, another, even more simplified view of morphemes is that they do not contain morphosyntactic information, in which case the morphosyntax circle would be absent from the representation in Figure 2.2.

[36] As we will see, the full gamut of representational stances of the approaches reviewed below contains a couple more cases. In the following sections, I will have a graph with the assumptions about representations that each approach makes, so that this will become clearer.

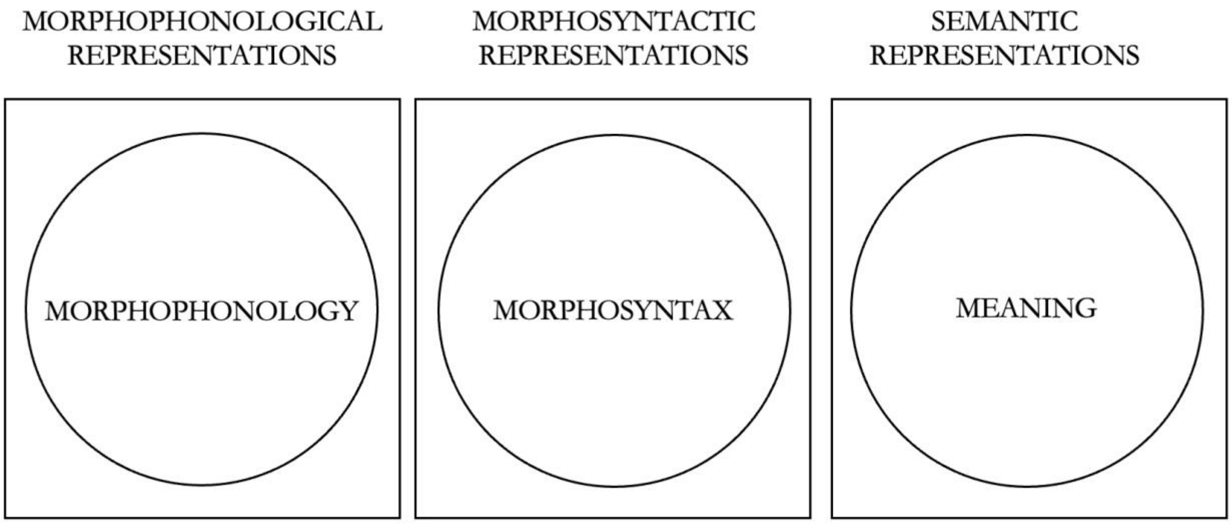


Figure 2.3: Distinct representations for meaning, morphosyntax and morphophonology.

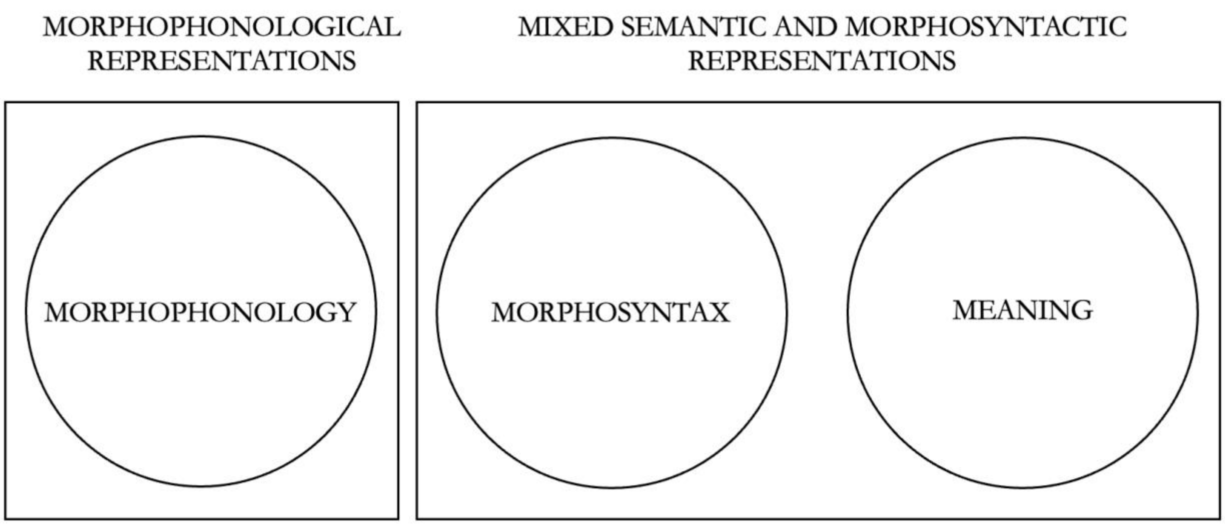


Figure 2.4: Mixed meaning-morphosyntactic representations distinct from morphophonological ones.

What is crucial though is that in current approaches to morphology, researchers distinguish between meaning/morphosyntax on the one hand, and morphophonological exponents on the other. In other words, instead of having a unit of form with a meaning (i.e., a morpheme), morphosyntactic objects (or mixed semantic/morphosyntactic objects) are mapped onto, or realised by, morphophonological forms (which are also called morphophonological 'realisations', thus the adjective 'realisational'). Since these mappings can be one-to-many (or even many-to-one in some theories), they allow us to account for the mismatches between form and meaning/morphosyntactic features that traditional morphemes cannot accommodate.

In a nutshell, all the theories of morphology we will look at are (at least to some degree) realisational. However, Distributed Morphology, Nanosyntax and Non-isomorphism also distinguish between morphosyntactic objects and their meanings.[37] In the jargon, it is usually said that morphosyntactic objects acquire their form at PF, and their meanings at LF. PF and LF are pre-Minimalist terms that persist to this day in some pockets of generative linguistics. In the inverted-Y model of language, shown in Figure 2.4, PF and LF are syntactic representations.[38]

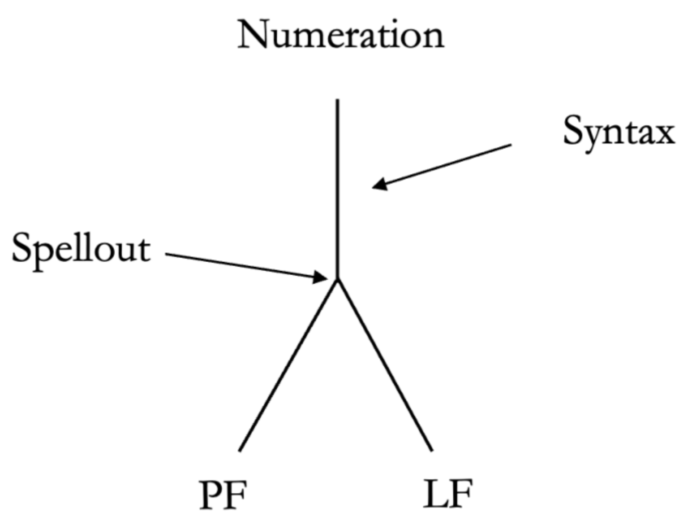


Figure 2.5: Inverted Y-model in the Minimalist framework (Chomsky, 1993).

[37] However, as we will see, Spanning doesn't seem to be concerned with the meaning of syntactic objects, and so isn't really concerned with LF either.
[38] Numeration is the choosing of the syntactic elements that will be used in the syntactic derivation. In Chomsky (1993) what enters the Numeration are words, while in the syntactic approaches to morphology reviewed here, it is syntactic atoms.

PF and LF are still used in this sense by some researchers (especially among syntacticians), but over time they also acquired another connotation (especially among morphosyntacticians), referring to the morphophonological and meaning components of the grammar, respectively. In other words, PF would correspond to the morphophonology circle, and LF to the meaning circle in Figure 2.1. It is in this latter (historically inappropriate) sense that PF and LF are usually used in Distributed Morphology, Nanosyntax, Spanning and Non-isomorphism.[39] This is also the sense in which they are used here. PF and LF are jointly referred to as the interfaces. There are many ways to say that syntactic representations are sent to the interfaces: they are 'spelled out', they are 'realised' or they are 'interpreted'. All of these terms are used interchangeably here. Similarly, Spellout is the operation that transfers morphosyntactic representations to the interfaces.

In the architecture of grammar presented in Figure 2.5, it is usually said that syntax 'precedes' PF and LF, and the morphosyntactic representations receive their meanings and their morphophonological realisations 'after' the syntax is 'over'. This way of speaking, which is typical of the Y-model, assumes that syntactic representations are created first and then sent to the interfaces. What happens in language production and language comprehension is probably something completely different. In production, we start with a semantic representation, which is translated into syntactic structure, which is, in turn, realised by morphophonological representations. In comprehension instead, from the incoming morphophonological representation, a morphosyntactic representation is inferred which is then translated into a semantic representation. While I don't think the Y model is an especially

[39] While I think this use engenders confusion between syntacticians and morphosyntacticians, since they are using the same terms for different things, I don't think it would be practical to come up with different terms here.

helpful way of thinking about linguistic representations, it is the way in which all the current theories of morphology (and of syntax for that matter) are stated, and thus I will adopt it here. However, 'before' and 'after' syntax should not be interpreted as temporal statements about how actual psycholinguistic computations unfold over time. It is also worth mentioning that since Anderson (1992) was written just before Minimalism became mainstream, it still adopts a distinction between D-Structure (Deep Structure) and S-Structure (Surface Structure). In other words, it uses the original version of the Inverted Y-model, as shown in Figure 2.6. This distinction was later abandoned by generative syntacticians and is not found in any other model reviewed here. [40]

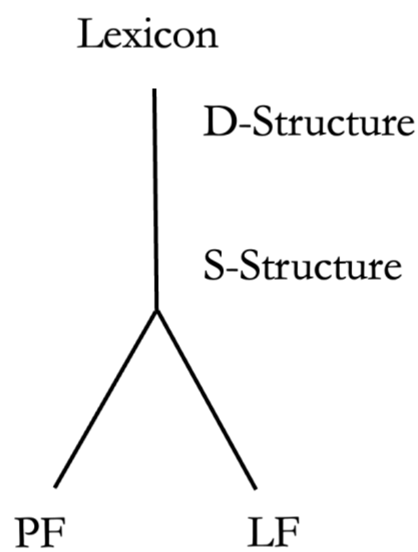


Figure 2.6: The Inverted Y-model in the Extended Standard Theory (Chomsky and Lasnik, 1977).

The clarifying comments made in this section should make the discussion in the following pages easier to follow. In a similar spirit, I will try to keep the same terminology throughout the rest of the

[40] The same caveat as for Figure 2.5 applies.

chapter to ensure internal coherence and better comparability among various approaches, even when this requires diverging from the terminology used by the authors cited. In order to do so, it will be useful to define the following terms. I use the term morphophonological exponent/form instead of simply phonological exponent/form. This is to acknowledge that there are morphophonological changes that are different from the regular phonological changes attested in the same language. Moreover, since not all the morphological approaches reviewed here agree that morphosyntax and syntax are one and the same thing, I will use the terms 'morphosyntax' (and 'morphosyntactic') instead of simply 'syntax' (and 'syntactic') throughout, even though for all the approaches other than A-morphous morphology, they mean one and the same thing. In what follows, I won't make much reference anymore to traditional morphemes, but when I do, I simply mean the smallest units of form with a meaning. A further terminological point is about roots and stems. As we will see, Anderson (1992) and Aronoff (1994) have a very specific definition of 'stem'. Other than that, I will not use this term further. On the other hand, I will use the term 'root' to refer to a morphosyntactic object. I will define 'root' in the section on Distributed Morphology and will assume it for all the other syntactic approaches to morphology. Finally, I will use the term root allomorphy to refer to cases where the two morphophonological forms of the root are phonologically similar to each other (e.g., *sing ~ sang*) and root suppletion cases where the two morphophonological forms of the root are phonologically similar to each other (e.g., *go ~ went*) (see section 2.3.2.5), even if this is not standard in DM. With this background in mind, we can now look at specific morphological approaches. We start with A-morphous morphology.

2.4.2 A-morphous morphology

A-morphous morphology is the title of Anderson's (1992) book, which deeply changed the morphological landscape in generative linguistics. It built on a long tradition of previous works, most prominently, Matthews (1972) and Aronoff (1976, 1988), and is later assumed by Aronoff (1994). While many researchers have been inspired by Anderson (1992), the subtleties of his work are not always adopted by later works (partially because his book is sometimes very cryptic). Here I try to make my best efforts to report on Anderson's (1992) system as stated in the book. Passing references to Aronoff (1994) are also made since these two works are in such close conversation with each other.

2.4.2.1 How A-morphous Morphology works

As suggested by its name, A-morphous morphology as a model sets out to propose a theory of morphology that completely eliminates any reference to morphemes, and to morphological structure. More specifically, it assumes that the objects morphology operates on are lexical items.[41] Lexical items are sets of semantic and syntactic properties that can be associated with one or more multiple morphophonological forms, which Anderson sometimes calls 'stems' (Anderson, 1992: 122).[42] Lexical items are basically words without inflection (Aronoff, 1994: 10-11), and they always correspond to

[41] The 'lexical items' of A-morphous morphology is different from the (various) definitions of 'lexical item' in psycholinguistics. It's just an historical accident that they are called the same. This is just one more piece of evidence that linguistics and psycholinguistics have been using the same terms, and meaning different things for a very long time. Aronoff (1994) uses the term 'lexeme' to mean the same thing as Anderson's (1992) 'lexical item'. The same reasoning applies to this term, as clearly pointed out by Aronoff and Sims (2023: 10).

[42] Anderson (1992: 122) clearly states: 'the same set of semantic and syntactic properties are associated with more than one lexicalized set of phonological properties: this is the case where we want to speak of a single 'lexical item' with more than one (at least partially) suppletive variant'. Similarly, Aronoff (1994: 39) calls different morphophonological forms the various 'stems' of the same 'lexeme'.

members of major lexical categories (e.g., verbs, nouns, adjectives etc).[43] Neither Anderson (1992) nor Aronoff (1994) provide a visual representation of what a lexical item should look like, but it seems that they have in mind something like (41), i.e., something not too dissimilar from lexical morphemes in the traditional view of morphemes. On the other hand, inflectional and derivational affixes are introduced by Word Formation Rules, and are not themselves morphological units (see below for more on this)

(41) /lʌv/ - 'to hold dear' - [[$_V$][+NP]]

As far as meaning of lexical items is concerned, Anderson (1992), building on Aronoff (1976), argues that lexical items are Saussurean signs, and that:

> 'the sign relation is a holistic one between a possibly complex form and its possibly complex meaning, [thus] it is not constrained by the relations between form and meaning of its originally constituent parts'.
>
> (Anderson 1992: 193)

In other words, A-morphous morphology accounts for the non-compositional meaning of words by arguing that the Saussurean sign, and therefore locus of unpredictable meaning, is the lexical item, instead of the morpheme.

[43] If you're asking yourself what a word is, Anderson (1992: 17) says that one could define words alternatively 'as phonological units; as the irreducible terminal elements of syntactic structure; as the domain of principles regulating the appearance of morphological material; as the basic elements of the lexicon'. He admits that these definitions usually, but not always, converge, and goes on to say that while there is a huge literature on these topics, he will 'make no attempt to do justice to [that] work'. Thus, we are left with no definition of word at all, and Aronoff is not very helpful either (see the brief discussion of the difference between 'word' and 'lexeme' in Aronoff, 1994: 7). Both authors seem to appeal to an intuitive notion of what a 'word' is. We will come back to how problematic it is to assume an intuitive notion of 'word'.

Lexical items are either underived or created in the lexicon by derivational Word Formation Rules. Derivational Word Formation Rules consist of the following:

> '-A formal Structural Description, specifying the class of input stems the rule can apply to and any additional conditions (such as membership in specified subclasses of forms);
>
> -A formal Structural Change, specifying the alteration the rule performs in creating the phonological form of the derived stem from the form of the input stem;
>
> -A Syntactic Structural Description and Change [...]; and
>
> -A Semantic Structural Description and change.'
>
> (Anderson 1992: 185)

Let us look at a concrete example to see how this works. *Able* adjectives in English are derived from transitive verbs using the following derivational Word Formation Rule.

(42) *WFR*: $[X]_v \rightarrow [X\text{əbl}]_{Adj}$

Condition: $[X]_v$ is transitive (i.e., [__+NP])

Syntax: 'Object' argument of $[X]_v$ corresponds to 'Subject' of $[X\text{əbl}]_{Adj}$

Semantics: '(VERB)' → 'capable of being VERBed'

(Anderson 1992: 186)[44]

As should be clear from (42), the Syntactic and Semantic Structural Descriptions describe respectively the syntactic and semantic characteristics of this rule. The semantic part of the rule provides the meaning that *able* adjectives usually have. However, when a new lexical item is created, it can take on a different

[44] Anderson (1992: 186-195) notes that the rule in (38) is a first approximation and should be slightly modified to account for various phenomena, such as verbs ending in -ate that lose this suffix in front of the *-able* suffix (e.g., *navigate ~ navigable*), intransitive verbs that can take an *-able* suffix (e.g., *perishable*), cases where there is no corresponding free verb (e.g., *possible*), and cases where the element *-able* attaches to is not a verb (e.g., *objectionable*). However, for our purposes, it doesn't matter what the actual rule is since we are just using it as an example to see how derivational Word Formation Rules work in general.

meaning: for instance, the adjective *cómparable* does not only mean ‘capable of being compared’ but also ‘roughly equal’ (see Anderson, 1992: 193). Anderson (1992: 193 building on Anderson, 1976) argues this is the case because lexical items are Saussurean signs, and can be the locus of unpredictable meaning.

Going back to the Word Formation rule in (42), $[X]_v$ is the formal Structural description (i.e., the phonological form of the original lexical item), and → $[X\text{əbl̩}]_{Adj}$ specifies the formal Structural Change, i.e., the morphophonological change that correspond to this change in meaning and form (in this case, adding the suffix /-əbl̩/). Importantly, the formal Structural Change allows many more changes to the stem than just affixation. Indeed, since Structural Change can operate on any part of the stem, it can accommodate cases where the form of a morpheme is not an affix, and instead corresponds to some other morphophonological change, such as apophonic and metathetic changes, non-concatenative morphologies and even subtractive morphemes (described in section 2.3.1). Thus, in this approach, derivational affixes are not separate morphological units, they are just the result of a phonological change that has created a new lexical item. In a nutshell, derivational Word Formation Rules take a lexical item and create a new one from it. They operate in the lexicon, and change the meaning, the form and the syntax of a lexical item. Moreover, since derivational Word Formation Rules are part of the lexicon, they precede and feed the syntax (see next section for more on this).

Surface wordforms are created by inflectional Word Formation Rules, that take a lexical item and turn it into a surface word. Inflectional Word Formation Rules are very similar to derivational Word Formation Rules in the formal changes they can engender (i.e., morphophonological changes beyond simple affixation), but they allow for the realisation of morphosyntactic features with a surface morphophonological form.[45] Since morphosyntactic features depend on the syntactic context, they have to operate after the syntax is complete (differently from derivational Word Formation Rules which precede the syntax). Inflectional Word Formation Rules operate on a pair {*P, M*}, defined as follows:

- P is 'a phonologically specified stem, together with any further lexical specifications associated with that stem' (Anderson 1992: 185)[46];
- M is a Morphosyntactic Representation that specifies the morphosyntactic features that have to be realised by that specific inflectional Word Formation Rule.

For instance, the Word Formation Rule for regular past tense in English, more specifically for stems that end in a voiceless consonant, would be something along the lines of (43). +past is the Morphosyntactic Representation of this rule, /X/→ /Xd/ specifies how the morphosyntactic feature is realised (in this case, adding the suffix /-d/).

(43) +past

/X/ → /Xd/[47]

Similarly to what happened with derivational affixes, inflectional affixes are not morphological pieces (Anderson [1992] dedicates a whole chapter, Chapter 10, to explaining why we should not assume word-internal morphological structure). However, inflectional affixes are usually ordered with respect to

[45] While Word Formation Rules could potentially account for cases of root allomorphy, Anderson (1992) deals with these cases by using different stems, and thus treats them in the same way as root suppletion. Indeed, Anderson (1992: 133) says: 'A lexical stem set P is a group of phonologically distinct stems {P1,P2, ...} with the same syntactic requirements and semantic interpretation, each associated with its own (partial) set of morphosyntactic properties. Individual stems can in this way be associated with morphosyntactic features (minimally, perhaps, indication of word class) that restrict the range of Morphosyntactic Representations in syntactic structure they can interpret'. See also Anderson (1992: 300-301) for a treatment of ablaut verbs in German which are similar to the *sing ~ sang* cases in English.

[46] Anderson (1992) never clarifies what he means by 'any further specifications associated with that stem'.

[47] Anderson (1992) does not provide a rule for the realisation of past tense in English, so I created this one by analogy with the inflectional Word Formation Rules provided in Anderson (1992: 177-179). Obviously, this rule would apply only to regular past tenses that do not end in a voiceless consonant, in /d/ or /t/.

each other. For instance, in Potawatomi, an Algonqian language, transitive inanimate verbs with second and third person plural subjects are characterized by 2 suffixes, namely *-na*, which is the marker of second and third person specific for these verbs, and *-wa*, which is a more general marker of non-first person plural elements (Anderson 1992, 167-168). The suffix *-na* always precedes *-wa* in Potawatomi, but Anderson (1992) cannot state this in terms of ordering of affixes since he denies the existence of any kind of word-internal morphological structure. Thus, in order to account for these facts, Anderson (1992) has to postulate morphosyntactic representations that have a complex internal structure, as the ones in (44-45). Moreover, he has to state that the inflectional Word Formation Rule in (44) precedes the one in (45). Thus, while A-morphous morphology can, on paper, account for the respective ordering of inflectional affixes, it has to do so in a very convoluted way (which, as will become apparent when we review other approaches to morphology, basically recapitulates syntactic structure within morphosyntactic representations).

(44)

$$\begin{bmatrix} +\mathrm{Pl} & [\ ] \end{bmatrix}$$

$$/\mathrm{X}/ \rightarrow /\mathrm{Xwa}/$$

(modified from Anderson 1992: 166)

(45)

$$\begin{bmatrix} +\mathrm{Verb} & \\ -\mathrm{me} & [-\mathrm{Anim}] \\ +\mathrm{Pl} & \end{bmatrix}$$

$$/\mathrm{X}/ \rightarrow /\mathrm{Xna}/$$

(modified from Anderson 1992: 168)[48]

2.4.2.2 The architecture of A-morphous Morphology

In order to better understand A-morphous Morphology, it will be useful to understand how the architecture of A-morphous morphology works or, in other words, how the different components of the grammar relate to each other in this theory. In A-morphous morphology, the lexicon is distinguished from the syntax: it is not only a repository of stored lexical items, but also a system of rules that can produce new lexical items via derivational Word Formation Rules (Anderson 1992, 182). In this sense, A-morphous morphology is a lexicalist theory, in the sense that it is centered on lexical items and on the ways the lexicon can create new lexical items.

Anderson (1992: 122) claims that lexical items 'interpret specific structural positions within Phrase Markers', making clear that this 'interpretation' happens at S-Structure (Anderson, 1992: 5). In more modern terms, we would probably interpret this to say that lexical items realise syntactic terminals. However, Anderson (1992) is not super clear on how this process works, and how the matching between Phrase Markers and lexical items is done. Anderson (1992: 133, see also footnote 45) claims that the morphosyntactic properties of a stem can restrict what syntactic structure they realise. Thus, it would

[48] In the main text, Anderson (1992: 167-168) gives *-na*, but then in the actual inflectional Word Formation Rule, he gives -*ma* as the phonological form. I assume this is a typo and follow the main text, and that's why the rule in (44-45) is modified accordingly.

seem that the morphophonological form of lexical items is inserted after its semantic and syntactic features, but the details of this are left largely unclear.

Inflectional Word Formation Rules seem to occur after the syntax is over, possibly on the way to PF, as shown in Figure 2.6. However, here too, Anderson (1992) is not very explicit about exactly how this process works. This is partly due to the fact that Anderson (1992) is more interested in providing an account of morphological patterns, rather than giving a full blown architecture of the grammar. Figure 2.7 is my attempt to provide a visual rendering of Anderson's (1992) system and is not provided anywhere in his book. Apart from the accuracy of Figure 2.7, what should be clear is that in Anderson (1992) not all of linguistic structure is derived syntactically, and that the lexicon produces new linguistic structure as much as the syntax does.[49]

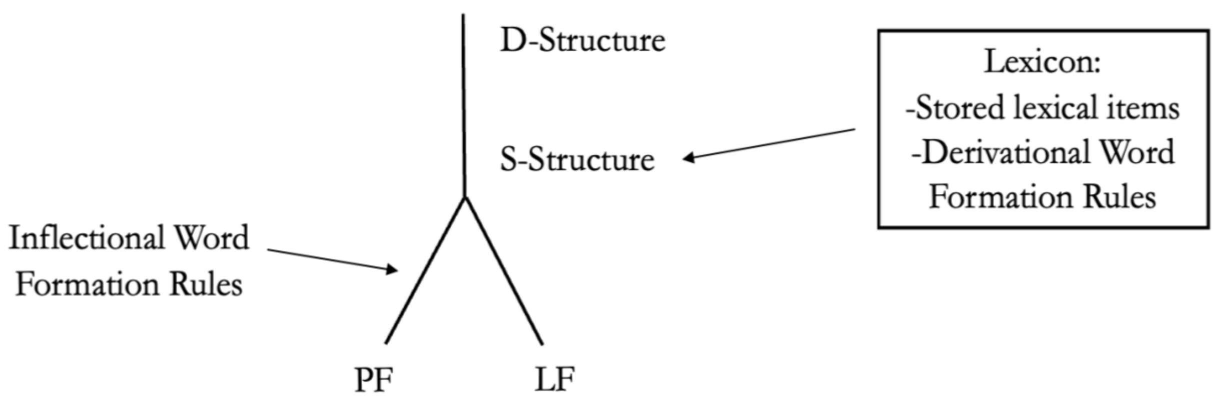


Figure 2.7: The A-morphous Morphology Architecture.

[49] There is nothing at the 'top' of the Inverted Y-model in this picture because Anderson (1992) is unclear about what enters the syntactic derivation in his worldview.

2.4.2.3 Taking stock

Let us summarise what we have seen until now. A-morphous morphology does away with morphemes. They are substituted by lexical items and Word Formation Rules that operate on them. Lexical items are sets of semantic and syntactic properties that can be associated with multiple morphophonological forms. Derivation Word Formation Rules, operating in the lexicon and thus before the syntax, create new lexical items, changing the meaning, form and syntax of the pre-existing lexical items. On the other hand, inflectional Word Formation Rules, that provide a morphophonological realisation to morphosyntactic features, create surface wordforms starting from lexical items. A-morphous morphology can easily account for all the form problems that traditional morphemes faced because the morphophonological changes engendered by Word Formation Rules are stated not in terms of concatenating morphemes together, but in terms of morphophonological processes carried out on lexical items.[50] Similarly, the cases of form/meaning mismatches that we reviewed in section 2.3.3.2 can be accounted for by Word Formation Rules since they relate meanings and morphosyntactic features to morphophonological changes, but do not require one-to-one mappings between pieces of meaning and pieces of form. Finally, the fact that words sometimes have non-compositional meanings is accounted for in A-morphous morphology by saying that lexical items, instead of morphemes, are Saussurean signs and, thus, the locus of unpredictable meaning.

In conclusion, A-morphous morphology is a hybrid realisational model, in which lexical items and morphosyntactic features are realised phonologically, while derivation occurs in the lexicon and thus

[50] However, as we have seen in footnote 45, morphophonological changes to roots (i.e., root allomorphy) is dealt with by having the same lexical item have more than one stem.

precedes syntax. In this approach, morphology is distinct from syntax and operates with devices, i.e. Word Formation Rules, that are different from syntactic operations. A-morphous morphology solves many of the empirical problems that traditional morphemes faced. However, since it argues against any word-internal structure, A-morphous morphology has to adopt a very convoluted way to account for the correct ordering of inflectional affixes. Moreover, since A-morphous morphology assumes that the lexical item is the Saussurean sign, it can't explain why idioms exist, i.e. why there are domains of unpredictable meaning above the word level. This is a symptom of a more general problem with A-morphous morphology: the fact that the authors in this literature do not define what a word is (and, thus, what a lexical item is), and instead seem to assume an intuitive notion of 'word' that, as we will see in the next section, is very difficult to define.

Table 2.1 provides an overview of A-morphous morphology and Figures 2.8 and 2.9 make it clear what kinds of representations lexical items and morphosyntactic features are respectively. In Figure 2.8, I show the representation for lexical items, where semantic and morphosyntactic are separated from their morphophonological realisation because the same lexical item can have multiple stems. In Figure 2.9, there is a representation for morphosyntactic features. Since Anderson (1992) does not say anything about how they are related to meanings, the meaning part of the representation is blurred out. On the other hand, the morphophonological realisation is distinguished from morphosyntactic features, but no square is present around the circle because inflectional affixes are not pieces in this theory.

A-morphous morphology	
(Q1)What are the basic elements of morphology in this approach?	Lexical items and morphosyntactic features.
(Q2) What's the relation between morphology and syntax in this approach?	Morphology and syntax are distinct. Creation of new lexical items happens in the lexicon via derivational Word Formation Rules.
(Q3) Is this a fully realisational approach?	No. While lexical items are inserted at SS and morphosyntactic features are realised post-syntactically, derivation is done in the lexicon.
(Q4) How are meanings derived in this approach?	Lexical items are Saussurean signs and thus can have non-compositional meanings.

Table 2.1: Theoretical assumptions of A-morphous morphology.

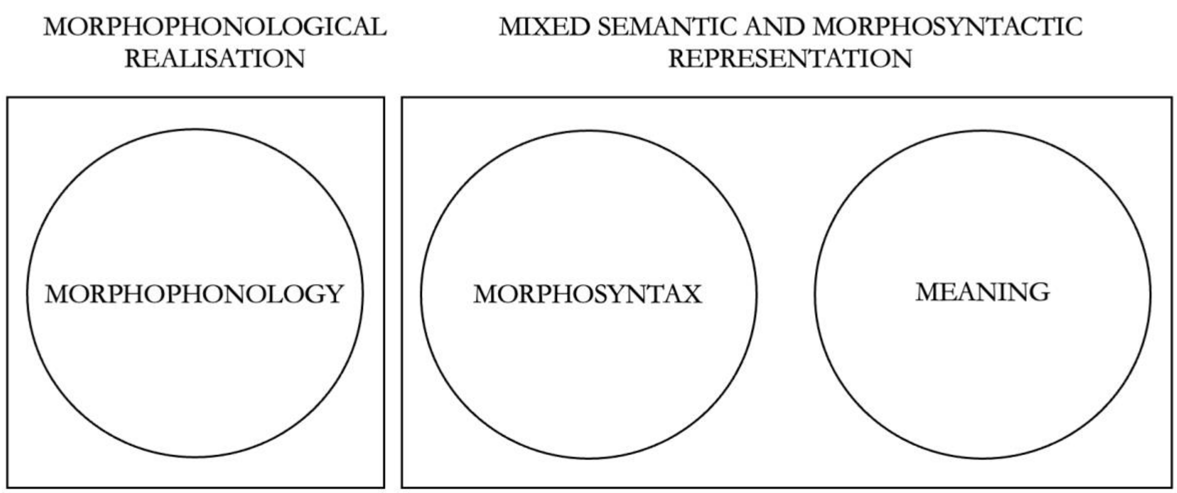


Figure 2.8: Schematic representations for lexical items.

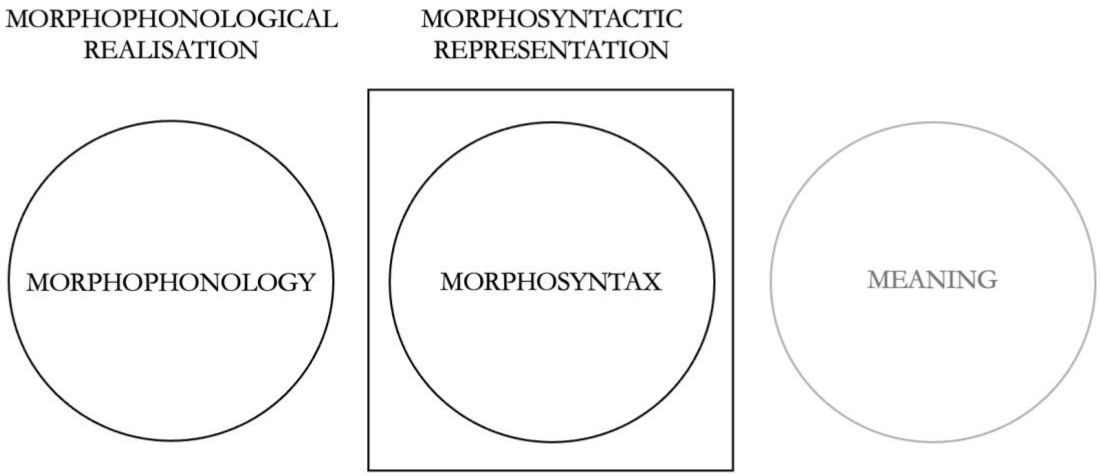


Figure 2.9: Schematic representations for morphosyntactic features.

2.4.3 Distributed morphology

As we have seen in the previous section, A-morphous morphology does away with traditional morphemes, and relies instead on lexical items and morphosyntactic features. Moreover, it argues that the mechanisms that build words (derivational Word Formation Rules) are different from the one that builds phrases: in other words, morphology is distinct from syntax. Distributed Morphology (DM) takes the opposite stance, and argues that there is no difference between the mechanism that operates below and above the word level: it is syntax all the way down, as the adage goes. Distributed Morphology, whose founding paper was the spirited response of Halle and Marantz (1993) to Anderson (1992), has been extremely influential in the world of generative linguistics in the last 30 years. It is probably fair to say that most contemporary generative morphological analyses adopt Distributed Morphology. This means that there are many voices in the field and, thus, there are sometimes disagreements among DM practitioners on theoretical issues. Here I do not attempt to do justice to the complex debates within

DM, and instead try to highlight the core theoretical assumptions DM practitioners adhere to, and how they relate to other contemporary morphological approaches.[51]

2.4.3.1 How DM works

Distributed Morphology maintains that the building blocks of language are not words, but morphosyntactic objects, more specifically roots and (bundles of) morphosyntactic features. Both roots and bundles of morphosyntactic features are purely syntactic objects that receive meaning at LF and morphophonological form at PF (Harley 2014).[52] Syntax operates on them to build complex syntactic structures, which are then sent to the interfaces to be interpreted. This is the reason why this theory is called Distributed Morphology: as Halle and Marantz (1993: 11) put it, 'the machinery of what traditionally has been called morphology is not concentrated in a single component of the grammar, but rather is distributed among several different components'.[53]

Let us see an example of how this works in practice. The verb *lovable* is made up of a root, let's call it root √17, a verbalising head *v*, and an adjectivising head *a*. In this case, we assume that there are

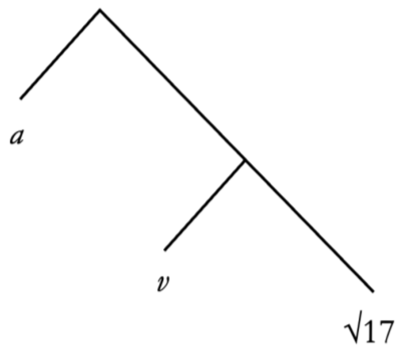
[51] Moreover, I can't do justice to DM-adjacent frameworks, such as the Exoskeletal Model developed by Borer (2005a, 2005b, 2013).

[52] Even if 'mainstream' DM assumes that roots are purely syntactic objects, there are important voices raised against this consensus. For instance, Embick (2015: 7-9) argues that roots have both phonological content and lexical-semantic meaning, while for Borer (2005 a, b, 2013) roots have phonological content. Assuming that roots have inherent phonological content would easily explain why there are very few cases of root suppletion within each language. Adopting Embick's (2015) or Borer's (2005a, 2005b, 2013) view means turning DM into a partially realisational approach, in which morphosyntactic features are realised at PF, while roots come already endowed with morphophonological material.

[53] However, these days DM practitioners refer to some post-syntactic operations like Fusion (see below) as 'morphological' operations, in a way that betrays at least the letter of Halle and Marantz (1993).

both a verbalising head and adjectivising head because, informally speaking, the suffix *-able* attaches to verb *love*.[54] Moreover, since roots are devoid of any meaning and morphophonological form, they are simply identified by numerical indices (Harley 2014). The root and the two heads are put together in the syntax, as shown in (46).

(46)



Each syntactic node in the tree in (46) is then spelled out by morphophonological form at PF. This is made possible by using mappings between syntactic nodes and their morphophonological forms, called Vocabulary Items. The relevant Vocabulary Items to spell out the tree in (46) are as in (47), and the process of realising syntactic nodes phonologically is called Vocabulary Insertion. The tree is spelled out from the bottom up, such that the most embedded terminal will be spelled out first in linear order. This is a very straightforward way to account for the correct ordering of affixes (which instead A-morphous morphology struggled with).[55]

(47) a. √17 ↔ /lʌv/

[54] However, differently from A-morphous morphology, the adjectivising head a that is spelled out as /əbl/ doesn't strictly need to attach to a verb. This provides a straightforward way to account for cases where it attaches to a noun (e.g., *objectionable*) or to a root that doesn't occur as free standing in the language (e.g., *possible*).

[55] In other words, this is a very straightforward way to account for Baker's (1985, 1988) Mirror Principle, whereby the order of morphemes in a word is usually the mirror image of the order of syntactic heads. See Embick (2015: Chapter 3) for an in-depth exploration of the relation between syntactic structure and linear order.

b. v ↔ ∅

c. +past ↔ /d/

Similarly, the meanings of the nodes in (46) are given in (48). The mappings in (48) are found in the Encyclopaedia, so we can call them Encyclopaedia entries (even though there doesn't seem to be an agreed upon name for these in DM as there is for Vocabulary Items).

(48) a. √17 ↔ 'love'[56]

b. *v* ↔ 'denotes an event'

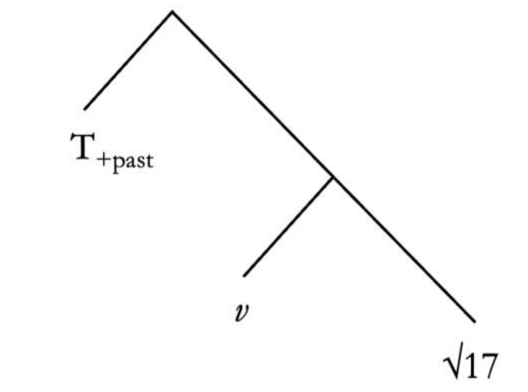
c. *a* ↔ 'capable of being VERBed'

It is these syntax-to-form mappings (i.e., Vocabulary Items) and syntax-to-meaning mappings (Encyclopaedia entries) that ensure the correct assignment of meaning and morphophonology to the various syntactic nodes, including roots. It is usually assumed in DM that syntactic structures are sent to Spellout when a phase is complete.

Differently from Anderson (1992), inflection and derivation work exactly in the same way (i.e., they are both syntactic, while in Anderson [1992] derivation occurs in the lexicon). So, for instance, the internal structure of *loved* would be something like (49).

[56] DM is really more a theory of how the mappings between syntax and PF than it is a theory of the mappings between syntax and LF. Thus, a full theory of meaning of each node is not always provided. I follow Harley in giving the meaning of the root between quotation marks. Moreover, the meaning I provide here for *v* is just a crude approximation for explanatory purposes. There is also debate in DM on whether there should be multiple verbalising, nominalising and adjectivising heads. For instance, the meaning of 'capable of being VERBed' seems to be specific to *-able*. So, perhaps, instead of having simply *a*, we should have something like a_3 that identifies it specifically as the adjectivising head that is spelled out as /əbl̩/ and whose meaning is 'capable of being VERBed'.

(49)



The only additional syntax-to-PF and syntax-to-LF mappings that we need to spell out (49), are as in (50-51).

(50) T_{+past} ↔ /-d/

(51) T_{+past} ↔ 'reference time is before utterance time'

The fact that syntactic nodes are purely syntactic elements allows them to have different morphophonological forms and different meanings in different contexts. For instance, the morphosyntactic head T_{+past} will be realised as Ø with irregular verbs of the kind we have seen in section 2.3.1.6, repeated here for convenience.

(52) a. *sing*	*sang*
b. *blow*	*blew*
c. *fly*	*flew*
d. *read*	*read*
e. *break*	*broke*
f. *choose*	*chose*
g. *dig*	*dug*

This is ensured by having syntax-to-PF mappings that are specified for the context in which they occur. For instance, the syntax-to-PF mapping for T_{+past} when co-occurring with these verbs would be something like (53).

(53) $T_{+past} \leftrightarrow \emptyset$ / √14, √48, √365, √1073, etc.

The slash after ∅ specifies the contexts in which +past is spelled out as ∅, which basically corresponds to a list of all the roots that take the ∅ allomorph of past tense. When the same syntactic element is coupled with multiple Vocabulary Items like (50) and (53), it will be spelled out according to the one that is more context specific. More generally, having syntax-to-PF mappings that are specified for a context of occurrence is the way in which DM deals with affix suppletion.

DM deals similarly with root suppletion. Thus, the same root will be spelled out according to the Vocabulary Items in (54).

(54) a. √132 ↔ /goʊ/

b. √132 ↔ /wɛn/ /[T_{+past}][57]

So far we have seen that in DM, suppletion cases are captured by assuming that a single syntactic element can have mappings to multiple Vocabulary Items, where how each one is spelled out is determined by the relative specificity of the rule contexts. On the other hand, DM accounts for root allomorphy by positing morphophonological 'Readjustment rules'. These Readjustment rules occur

[57] In DM, the /t/ in /wɛn/ is usually assumed to be the spell out the T_{+past} head. However, if one doesn't think the form /wɛnt/ is internally complex, this syntax-to-PF mapping would simply be √132 ↔ /wɛnt/ /[T_{+past}] instead, and we would have the head T_{+past} be spelled out as ∅ in the context of root √132 too.

after Vocabulary Insertion and modify the morphophonological form that was introduced by the Vocabulary Item. Let us see an example of this. The Vocabulary Item for *sing* would be as in (55) in all syntactic contexts.

(55) √475 ↔ /sɪŋ/

However, after Vocabulary Insertion has happened, ɪ will be turned into æ by a morphophonological Readjustment rule, along the lines of (56). Thus, in (mainstream) DM, root suppletion and root allomorphy are treated differently.[58] The reason behind this is that in root allomorphy but not in root suppletion, the two morphophonological forms of the root are phonologically similar to each other.

(56) ɪ → æ / W___U [T_{+past}] where WVU = /sɪŋ/, /rɪŋ/, /gɪv/, ...[59]

Readjustment rules are the way through which DM deals with apophony and, potentially, the way it could deal with metathesis.

The remaining morphophonological phenomena that we reviewed in section 2.3.1 are dealt with in the following way. Kalin (2022) argues that infixes and circumfixes are similar to other affixes but attach in different places. Kastner (2019) clearly shows how marrying the morphosyntactic assumptions DM with an Optimality Theory phonological implementation can account for templatic effects in morphology. On the other hand, it is less clear how DM can deal with reduplication and subtractive

[58] However, for a more fine-grained discussion of suppletion and different approaches to deal with it, see Mascaró (1996), Nevins (2011) and Brodkin (2024) among others.
[59] This Readjustment rule was created by analogy with the Readjustment rules for irregular past tenses in English provided by Halle and Marantz (1993: 128).

‘morphemes’ since these entail more complex morphophonological operations, so it will largely depend on what theory of phonology DM is coupled with.

As far as mismatches between meaning and form go (see section 2.3.2), the fact that DM severs the link between meaning and form by inserting a syntactic node that mediates between the two allows it to easily account for all these cases. As we have seen above, morphosyntactic nodes can be spelled out by null phonological exponents. Similarly, superfluous exponents could be treated as syntactic nodes with no meaning.[60] Double exponence will be dealt with by having a morphosyntactic feature being spelled out by a morphophonological form and at the same time let the presence of this morphosyntactic feature influence the realisation of the morphophonological form of the root (either via a different Vocabulary Items as in root suppletion or via Readjustment rules for root allomorphy). Portmanteau ‘morphemes’ will be found when more than one syntactic feature is realised by a single morphophonological form. This will happen for instance in cases where already in the syntax a single node carries more than one syntactic feature (in other words, a single node is a bundle of features).[61] Another way that DM has to deal with ‘portmanteau morphemes’ is by joining two syntactic heads into one post-syntactically, in a process called Fusion (see Halle and Marantz [1993: 133] and much subsequent work). While we won’t go into how Fusion works here, not all DM practitioners are

[60] However, there is actually a lot of debate on what theme vowels, which are a prime example of superfluous ‘morphemes’, are in Romance and in similar languages (e.g., Oltra Massuet, 1999; Grestenberger, 2022; Kovačević et al., 2024 among many others).

[61] In theory, there is no constraint on how many features can be hosted on a single head. In practice though, the number of features that a syntactic head can have is usually limited and it is dictated by the morphophonological pieces they are spelled out by. For instance, as we saw in section 2.3.2.3, in Italian, the same ending specifies both gender and number. In DM, this will mean that it is the spellout of a single head that carries both gender and number features.

comfortable with having such powerful post-syntactic operations that are able to modify the syntactic structure.

2.4.3.2 Meanings in DM

We have seen how DM deals with most of the problems that traditional morphemes had, but we still need to know how it can deal with unexpected meanings, i.e., meanings that cannot be derived from the meaning of their constituent parts. It is worth noting that the DM theory is not as developed with regard to meaning as it is with morphophonology. However, differently from other contemporary approaches to morphology, in DM there is at least an attempt to work out the details of the relationship with meaning. Let's see the example of *understand* from above. The default (or elsewhere) meaning of the root √368, which is spelled out as /stænd/, is as in (57a) where there is no specification of context. However, the meaning of √368 changes when it is found in the presence of the prefix *under*, as shown in (57b). Similarly to what happened with Vocabulary Items in the previous section, different meanings can be attributed to the same syntactic node in different contexts, and the more specific one will win over the more general one.[62]

(57) a. √368 ↔ 'stand'

[62] Differently from Vocabulary Items, the LF mappings that are provided in the DM literature usually specify not only the syntactic structure in which they occur, but also how that syntactic structure is actually spelled out. If one assumes that syntax always mediates between LF and PF and no direct communication between the two is allowed, then these LF mappings should be stated in terms of syntactic terminals rather than in terms of spelled out phonological forms. While this is not usually how LF mappings are in DM, it seems to me like this change could be easily implemented. However, it is worth noting that the assumption that there is no direct communication between PF and LF is sometimes given up in DM (see e.g., Siddiqi 2010, 2019 among others).

b. √368 ↔ ‘comprehend’ / [under [__]]

The same mechanism can be used for some of the other cases where we find unexpected meanings in English: for example, particle verbs, Latinate roots and idioms. In (58) we can see the PF and LF mappings for the verb *throw*. (59) instead shows some of the meanings the Latinate root *ceive/cept* can have, while also highlighting that there is no elsewhere meaning for this root: in other words, differently from the case of *throw*, we can’t assign it a context-independent meaning.

(58) Syntax-to-PF mappings[63]	Syntax-to-LF mappings
√77 ↔/θrow/[64]	√77 ↔ ‘throw’
	√77 ↔ ‘vomit’ /[v [[__]$_{\surd}$ [up]$_{P}$]]$_{vP}$[65]

(59) Syntax-to-PF mappings	Syntax-to-LF mappings
√683 ↔ /si:v/	√683 ↔ ‘think’ /[v [[con-]$_{P}$ [__]$_{\surd}$]]$_{vP}$
√683 ↔ /sɛpt/ [. . .[ ] n_{event}]	√683 ↔ ‘fake’ /[v [[de-]$_{P}$ [__]$_{\surd}$]]$_{vP}$

(modified from Harley 2014: 244-245)

In (60-61) we can see that the same mechanism can be used to construct the meaning of idioms, such as *spill the beans*.

(60) Syntax-to-PF mappings Syntax-to-LF mappings

[63] Harley (2014) actually calls these ‘PF instructions’ and ‘LF instructions’, but for internal consistency reasons I am calling them ‘Syntax-to-PF mappings’ and ‘Syntax-to-LF mappings’ instead.
[64] Only one PF mapping is given for root √77 since its past tense will be derived from /θrow/ via a readjustment rule.
[65] If this is the correct analysis of *throw up*, it is actually unclear what the meaning of up would be in this context. This is a general problem with DM treatment of meanings. More on this below.

$\sqrt{99} \leftrightarrow$ /spɪl/ $\sqrt{99} \leftrightarrow$ 'spill'

$\sqrt{99} \leftrightarrow$ 'divulge' /$[[\text{ v } [\ \_\_\ ]_{\surd}]_{vP}\ [[+\text{def}]_{D}\ [\text{beans}]_{NP}]_{DP}]_{VP}$

(61) Syntax-to-PF mappings Syntax-to-LF mappings

$\sqrt{62} \leftrightarrow$ /bi:n/ $\sqrt{62} \leftrightarrow$ 'bean'

$\sqrt{62} \leftrightarrow$ 'secret'/$[[\text{ v } [\text{spill}]_{\surd}]_{vP}\ [[+\text{def}]_{D}\ [\text{-sg }\_\_]_{NP}]_{DP}]_{VP}$[66]

(modified from Nevins 2017: 50)

Thus, DM has a way to account for the different meanings that the same root can have in different contexts by having different syntax-to-LF mappings in different syntactic contexts. Since both words and phrases are built syntactically, the same mechanism to account for non-compositional meanings can be used both above and below the word level. However, there are many open issues in this regard. First of all, there is a question about 'how much' syntactic structure is visible at PF and LF. There is a lot of debate in DM about how big is the domain in which syntactic nodes can influence the morphophonological realisation of the surrounding syntactic nodes. Without going into the specifics of that, it is usually assumed that this domain is usually very small, and sometimes argued to be just the next syntactic head (see Embick [2010] and Bobalijk [2012] among others). On the other hand, the domain in which the meaning of roots is influenced by the meaning of other roots in idioms can be as big as the whole VP, which is a pretty big domain. Moreover, at PF more specific mappings always win over less specific ones, that is, a suppletive form is always used over the base form. On the other hand, some more

[66] -sg refers to the fact that for the idiom meaning to surface, root $\sqrt{62}$ has to be pluralised (in other words, there is no idiomatic meaning available for *spill the bean*). However, this -sg feature is not necessarily interpreted since the idiom *spill the beans* can be used even when only one secret has been revealed.

specific LF mappings do not rule out less specific ones. For instance, a non-idiomatic meaning is available for *spill the beans*.[67] These first two issues are really questions about how similar PF and LF are, and whether the same principles apply to both interfaces, which is an open debate in DM.

A further issue is architectural. Indeed, DM espouses the idea that only morphosyntactic nodes can be mapped onto morphophonological forms and onto meanings, and thus require isomorphism between meaning domains and morphophonological domains (see next section).[68] Because of this strict one-to-one requirement, DM will struggle more with cases where not all the morphophonological pieces seem to have a meaning. For instance, for idioms like *hold your horses*, it doesn't seem like each of its parts has a meaning and, instead, the whole idiom means something like 'be patient'. The same can be said about phrasal verbs like *throw up*, where it is the combination of *throw* and *up* that means 'vomit', and not its parts. While calls for more careful investigation of the meaning side of morphology are present in some corners of the literature (see e.g., Borer, 2005; Carston, 2024), a better account of these data is still to be provided in DM.

2.4.3.3 The architecture of DM

The previous sections provided an overview of how the Distributed Morphology works, and how it accounts for the empirical facts presented in section 2.3. In this section, instead, we step back to

[67] This optionality in interpretation is not found only in idioms, but also with the interpretation of words. For instance, transmission can have both the compositional meaning of 'the act of transmitting' and the idiomatic one of 'the machinery that brings the power produced by the engine to the wheels of a vehicle'.
[68] As we will see, Spanning, Nanosyntax and Non-isomorphism make different assumptions in this respect, allowing for bigger stretches of syntactic structure to be spelled out at LF and PF.

look more closely at what the DM architecture entails. DM is centered around syntactic nodes, and how they are realised at PF and LF. These syntactic nodes are stored in what DM calls List 1, while syntax-to-PF mappings are stored in List 2 (the Vocabulary) and, finally, the syntax-to-LF mappings are stored in List 3 (the Encyclopaedia). Thus, in DM, there isn't a single lexicon where arbitrary mappings between syntax, form and meanings are listed. Instead, there is a list of syntactic elements and, then, separate lists for syntax-to-PF mappings and syntax-to-LF mappings. The whole DM architecture is shown in Figure 2.10.[69]

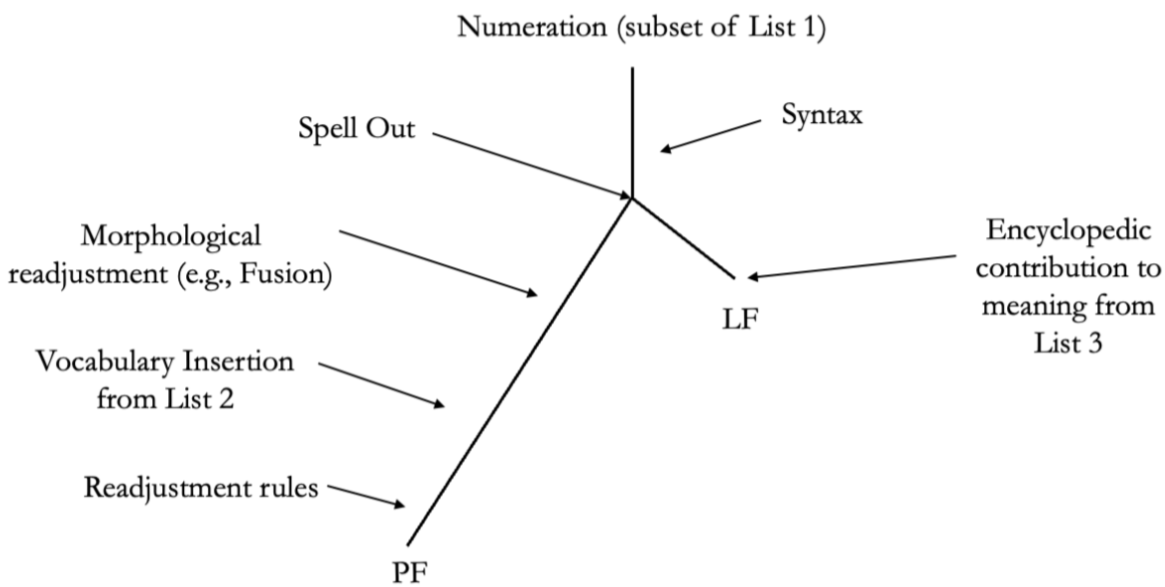


Figure 2.10: The Distributed Morphology Architecture (modified from Harley [2014: 228]).

In DM, the notion of word (or Anderson's [1992] related notion of lexical item) as that of a unitary object that is the locus of arbitrary meaning and phonology, and that can be operated on by

[69] Figure 2.10 differs from Harley's (2014) in two ways. First of all, I mention only Fusion (and avoid listing other 'morphological' operations such as Impoverishment, Fission, M-Merger that we didn't review here). Secondly, I moved Vocabulary Insertion, which in Harley's (2014) happens at PF, a little earlier on the branch that leads to PF to accommodate the presence of Readjustment rules, which are not present in Harley's (2014) diagram.

syntactic rules is abandoned. Instead, syntactic atoms are roots or bundles of features that receive their meanings and morphophonological exponents after the syntax is completed. DM argues that only syntactic nodes can be the locus of PF and LF realisations and, in this sense, DM is still a morphemic theory. Indeed, in DM, the syntactic nodes, stored in List 1, are usually referred to as '(abstract) morphemes' (see Marantz [2013], Embick [to appear] among others). This term was originally proposed by Halle (1990) to distinguish traditional morphemes, which he called 'concrete morphemes', from a more abstract notion of morphemes as syntactic units that will acquire a morphophonological realisation only later on in the derivation. Here I have avoided the term '(abstract) morpheme' to refer to syntactic nodes since I think this might lead to confusion.[70] The main difference between traditional morphemes and DM morphemes is that in the former meaning, syntax and form travel together from the beginning and cannot be dissociated, while in DM syntactic atoms can be connected to multiple morphophonological forms and multiple meanings depending on the syntactic context. Figure 2.11 clearly shows the dissociation of syntax, morphophonology and meaning in DM.[71]

[70] This is one of the things Aronoff and Sims (2023: 11) seem to have in mind when they say that 'differences of terminology obscure what is a fundamental level of agreement' among morphologists.
[71] Though interestingly in DM, List 1 is a list of syntactic nodes, while List 2 and List 3 are lists of *mappings* between syntactic nodes and PF and LF elements, not lists of meanings or morphophonological exponents.

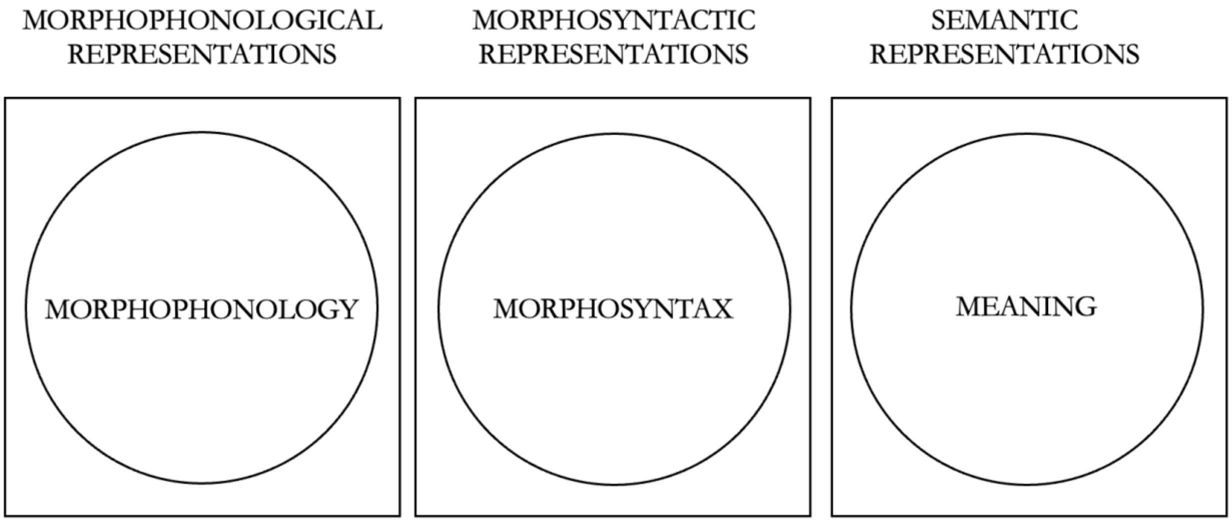


Figure 2.11: Distinct representations for meaning, morphosyntax and morphophonology.

As we will see in the next sections, other syntactic approaches to morphology object to the assumption that only syntactic nodes can be spelled out at PF and LF, and instead argue that larger stretches of syntactic structure can be realised at PF and LF. In this, they are a hybrid between DM and A-morphous morphology: they argue that words are built syntactically like DM, but argue that the locus of unexpected meaning and unexpected morphophonology can be bigger than a single syntactic node.

2.4.3.4 Taking stock

Distributed Morphology is a syntactic approach to morphology, where syntactic atoms are merged together through a syntactic derivation and then realised by syntax-to-PF mappings and syntax-to-LF mappings. It is a fully realisational approach in that the meanings and the morphophonological forms of syntactic nodes are inserted only after the syntactic structure has been built and a phase boundary is reached. DM can be still defined as a 'morphemic' approach since it argues that only syntactic nodes, i.e., 'abstract morphemes', can be mapped to special meanings and special forms. While

Distributed Morphology can account for the majority of the empirical cases in section 2.3, it struggles a little more with reduplication and subtractive morphology, as well as cases where the meaning of words or phrases doesn't seem derived from the meaning of its constituent syntactic nodes. This is because of the central role that individual syntactic nodes play in DM, which is questioned in other syntactic approaches to morphology as we will see in the next sections.

Distributed Morphology	
(Q1)What are the basic elements of morphology in this approach?	Syntactic nodes, i.e., roots and bundles of morphosyntactic features, as well as the syntax-to-PF mappings (Vocabulary Items) and the syntax-to-LF mappings (Encyclopedia entries) that ensure their correct PF and LF realisations.
(Q2) What's the relation between morphology and syntax in this approach?	Morphology is distributed across different modules of the grammar. Syntactic nodes are merged in the syntax and then realised by syntax-to-PF mappings and the syntax-to-LF mappings. Post Spellout operations like Readjustment rules will take care of morphophonological phenomena.
(Q3) Is this a fully realisational approach?	Yes, syntactic nodes are realised after the syntactic structure is built.[72]
(Q4) How are meanings derived in this approach?	Via syntax-to-LF mappings that specify the contextual meaning of syntactic nodes.

Table 2.2: Theoretical assumptions of Distributed Morphology.

[72] However, if one adopts Borer's (2005a,b; 2013) and Embick's (2015) view that roots are not purely syntactic objects, then the approach is not realisational with regard to roots. See footnote 52 for more on this.

2.4.4 Nanosyntax

Just like DM, Nanosyntax (Caha, 2009; Starke, 2009 among others) is a syntactic approach to morphology. This means that words and phrases are both built syntactically. Differently from DM though, Nanosyntax assumes that each syntactic feature corresponds to its own syntactic head. Let us see what this means in practice. As we have seen above, Italian nouns always have a single ending for gender and number, as shown in (62).

(62) a. *cas-a* *cas-e*

'house-sing.fem' 'houses-plur.fem'

b. *piatt-o* *piatt-i*

'plate-sing.masc' 'plate-plur.masc'

DM would assume that there is a single syntactic head hosting the morphosyntactic features for both gender and number (see footnote 61). Nanosyntax instead maintains that there are two separate syntactic heads, one for gender and one for number, even if in Italian nouns they are never realised separately.

Having a separate syntactic head for every feature entails two things: the syntactic atoms are much smaller and, as a consequence, the syntactic trees are much bigger (Caha, 2009). This is what the name Nanosyntax refers to: a radical subdivision of syntactic heads into extremely small units. This extreme decomposition is inspired by Cartographic approaches to syntax (e.g., Cinque and Rizzi, 2008 among others), where what are thought of as unitary projections in other syntactic approaches are split into multiple projections. Given that syntactic atoms are much smaller in this approach than in DM, Nanosyntax has to give up on the strict one-to-one correspondence between syntactic terminals and morphophonological realisations that is typical of DM. Instead, morphophonological forms will realise multiple syntactic heads. As we will see in section 2.4.4, Spanning makes similar theoretical assumptions to Nanosyntax in this respect. [73]

In the next section, we will briefly review how Nanosyntax works. The aim is not to provide a full overview of Nanosyntax, but more to paint in broad strokes what the Nanosyntactic architecture entails, and can achieve. For a very clear comparison between DM and Nanosyntax, the interested reader should refer to Baunaz and Lander (2018).

2.4.4.1 How Nanosyntax works

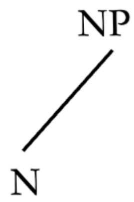
In order to understand how Nanosyntax works, let us see how it deals with the plural *dogs*. We start with a nominal root, N, which projects its own phrase NP, as shown in (63). This is an S-tree, i.e., a syntactic tree that has been built in the syntax.[74]

---

[73] Nanosyntax and Spanning on the one hand, and DM on the other are, in a nutshell, opposite ways of deciding on what a syntactic head is. Indeed, there is no direct way to deduce what constitutes a syntactic atom in a language (or crosslinguistically), but there are two kinds of evidence that the analyst can rely on to do so: meaning atoms and morphophonological pieces. Since Nanosyntax and Spanning share the a-priori assumption that each meaning corresponds to a syntactic head, the number and kind of syntactic heads will be dictated by their meanings. In DM, no such assumption is made and, in practice, this means there is a tendency in DM to prioritise morphophonological information over meaning when deciding what constitutes a syntactic head. However, meaning is still important in DM too. Thus, when there is evidence for a morphosyntactic feature because of meaning but no reflex of it in the morphophonology, DM will postulate a Ø head (see for example the treatment of verbs with irregular past tenses above). The tendency of DM to rely more on morphophonological evidence is partially due to the fact that it still relies on a 'morphemic' worldview (see section 2.4.2.3). At any rate, since the choice of what constitutes a syntactic head is, at least partially, a matter of analytical preference, it is only natural that these two opposite approaches are found in the literature.

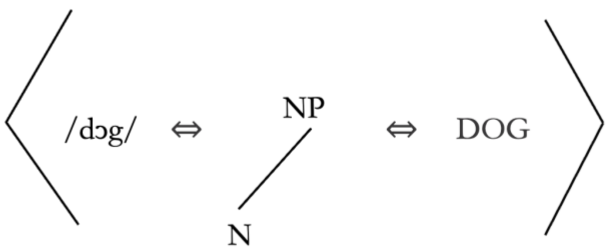
[74] The syntactic tree in (60) looks slightly different than the trees the reader might be used to. This is just because instead of having a straight line for heads, Nanosyntax adopts a slanted one.

(63)



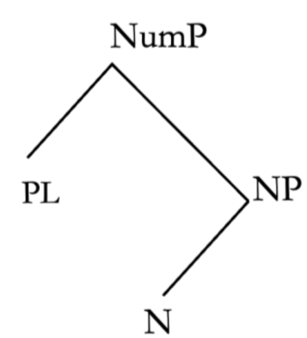
S-trees are lexicalised by lexical entries found in the Lexicon. Lexicalisation proceeds cyclically and it is attempted at each XP, in what is called Cyclic Exhaustive Lexicalization (Fábregas, 2007; Ramchand 2008; Pantcheva, 2011). Lexical entries associate a syntactic structure, i.e., an L-tree (where L stands for 'lexical'), with a morphophonological form and a meaning, as shown in (64).[75]

(64)



After lexicalisation of the first XP has been attempted, more syntactic structure is added. In this case, the number projection, NumP carrying a plural feature, is inserted above NP, as shown in (65).

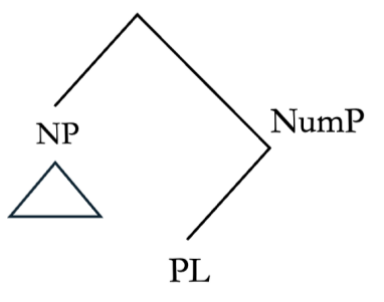
(65)



[75] Notice that these triplets of syntactic structure, meaning and form are not too dissimilar from traditional morphemes (more on this in section 2.4.3.2). However, as we will see below, not every lexical entry has to have a meaning component and a phonological form.

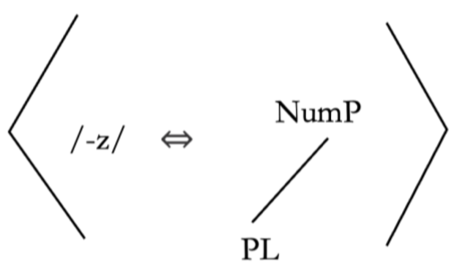
As we have seen above, in Nanosyntax, only maximal projections can be spelled out. Since in this structure PL is a head, it can't be spelled out on its own. Thus, its complement, NP, is moved higher than NumP, such that NumP is now a phrase to the exclusion of NP and can be spelled out, as shown in (66). This kind of movement is called Spellout-driven Movement, and it is not usually postulated outside of Nanosyntax.[76]

(66)



At this point, the lexicon can be searched again to look for a lexical item that matches NumP. The lexical entry like (67) will be found.[77]

(67)

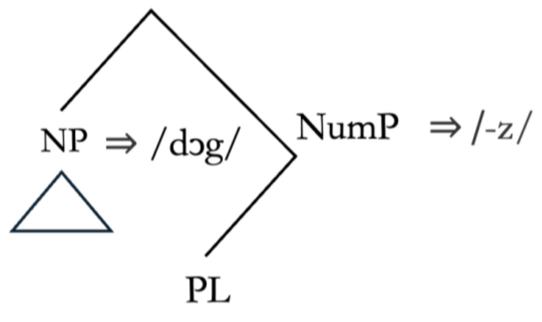


[76] As will see in following sections, the desire to do away with this kind of movement, is at the basis of another theory of morphology, Spanning, which starts with similar theoretical assumptions to Nanosyntax, but adopts a completely different implementation.

[77] While lexical entries without a meaning component are allowed in Nanosyntax, the lexical entry given in (67) is not actually taken from a Nanosyntactic paper, and was created by me in the spirit of Nanosyntax. The reason for this is that lexical entries for inflectional items are usually given without a meaning component in Nanosyntactic papers. However, it seems to me that this could be more of a convenient shorthand than an actual theoretical commitment. Thus, a lexical entry for plural specified for meaning could potentially be equally plausible.

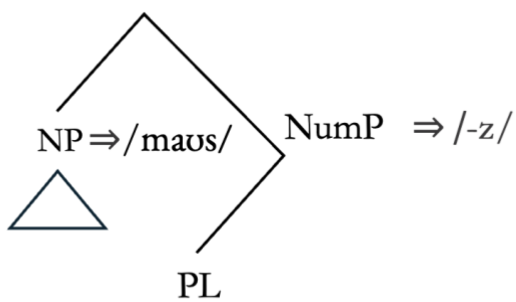
Thus, the whole S-tree in (66) is lexicalised as in (68).

(68)



Now that we have an idea of how a regular plural like *dogs* works, let us see how an irregular plural like *mice* works instead. Its internal structure will be exactly the same as the one in (66), and it will be initially lexicalised similarly to (68), as shown in (69).[78]

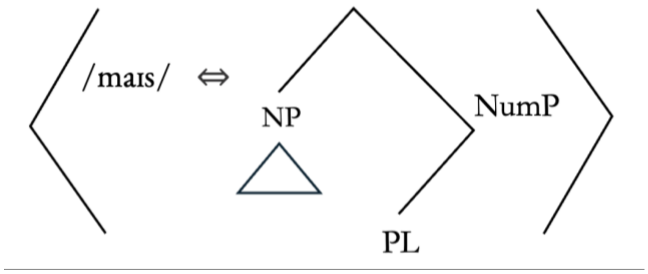
(69)



However, if we search the Lexicon again, we realise that there is a lexical entry, shown in (70), that can spell out the top node in the tree in (69). This lexical entry doesn't have any meaning component, because its meaning refers to the meaning of already existing lexical entries, in this case the one for *mouse* and *-z*.

[78] This is because Nanosyntax allows for the free choice when inserting roots in nodes like N (Caha et al., 2021).

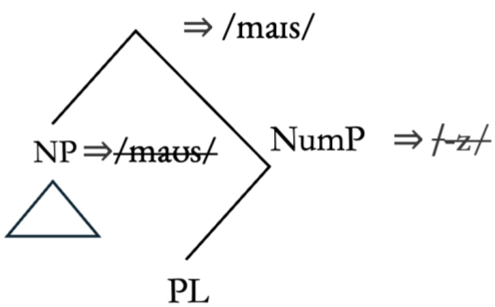
(70)



(modified from Baunaz and Lander, 2018: 56)

Since the lexical entry in (70) exists, the previous lexicalisations are phonologically overridden and the higher node is lexicalised instead, as shown by (71). This is possible because of the Principle of Cyclic Override.

(71)

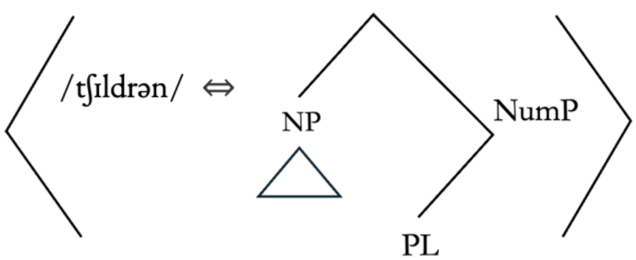


(Baunaz and Lander, 2018: 56)

Let us step back for a second and reflect on what this means. First of all, in this approach, the whole form *mice* is plural, and there is no ∅ spelling out plural, as there would be in a DM analysis of this phenomenon (see section 2.4.2.1 for a parallel case of past tense being spelled out as ∅ in verbs with irregular past tenses). Moreover, it is just an accident that the morphophonological forms /maʊs/ and /maɪs/ are phonologically similar. In other words, Nanosyntax deals with root allomorphy and root suppletion in the same way, namely by postulating that the two forms of an allomorphic or suppletive root correspond to different lexical items spelling out different stretches of syntactic structure. Instead, as we have seen, standard DM treats root suppletion and root allomorphy as two different phenomena. In order to do so, however, it has to introduce the additional machinery of Readjustment rules.[79]

Moreover, the analysis of *mice* in (68) will need to be adopted for *children*. Indeed, Baunaz and Lander (2018) maintain that *children* is not a morphophonologically complex form, and is just like *mice*, a single morphophonological form that spells out the higher node, as shown in (72).

(72)



In English the number of cases where we have a morphophonological change in the root co-occurring with a different spell out of the affix are rare, and thus the choice on how to analyse these data as morphophonologically complex or not will largely depend on personal and sociological preferences of the analyst.[80] However, crosslinguistically, there are more robust cases of 'double exponence', such as, for instance, irregular verbs in Italian taking different 3rd plural endings than regular verbs (see section

[79] As we have seen, treating root allomorphy and root suppletion as the same or different phenomena sometimes boils down to personal preferences of each analyst. However, there is a difference in the 'technical' possibilities afforded by the two theories. If one wanted to treat root allomorphy and root suppletion in the same way in DM, one could just avoid postulating Readjustment rules. On the other hand, in Nanosyntax, there is simply no way to treat root allomorphy and root suppletion as different phenomena since no morphophonological operation after Spellout is allowed. However, Nanosyntacticians see this as a perk of their approach since they argue that Nanosyntax doesn't require any additional mechanisms apart from Spellout.

[80] As should be clear by now, a Nanosyntactician will be less inclined to argue that *children* is morphophonologically complex since Nanosyntax allows for spellouts of bigger chunks of structure independently. On the other hand, a DM practitioner will be more inclined to say so since DM is more fine-tuned to find morphophonological pieces.

2.3.2.6). In order to analyse cases like this as morphophonologically complex in Nanosyntax, one would need to postulate a different syntactic structure for the irregular plural and make use of pointers (Turk, p.c., see also Caha and Pantcheva, 2012). While we don't have space to go into this here, it is clear that Nanosyntax struggles more than DM to account for 'double exponence'.[81]

Idioms are, in some sense, the mirror image of irregular phonological forms.[82] Indeed, they are lexical entries without any phonological content, which use the phonological content of already existing lexical entries. Let us see how this works in practice. The lexical entry for the idiom *hold your horses* is as in (73).

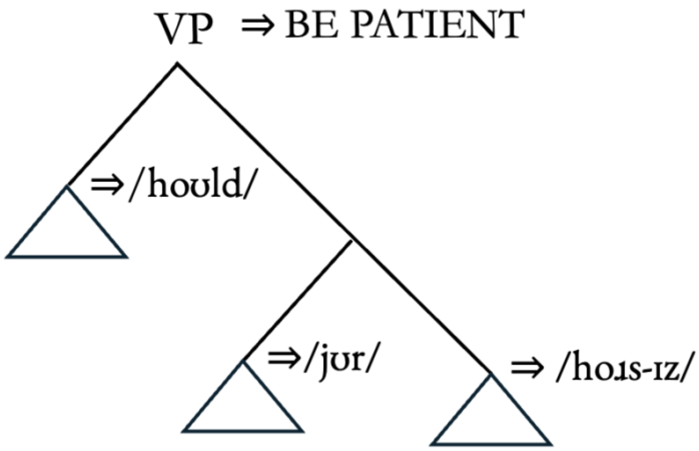
(73) $$\left\langle [_{\mathrm{VP}}\ \textit{hold}\ [\textit{your}\ [\textit{horse-s}]]] \quad \Leftrightarrow \quad \text{BE PATIENT} \right\rangle$$ [83]

(Baunaz and Lander, 2018: 57)

It will be inserted at the VP node such that the meaning of the whole VP will be 'be patient', however the phonological lexicalisations will apply to smaller structures, as shown in (74).

[81] As we will see in section 2.4.4 and 2.4.5, these worries do not apply to Spanning and Non-isomorphism.
[82] Indeed, in Nanosyntax, irregular phonological forms are called 'phonological idioms' (Baunaz and Lander, 2018: 56).
[83] Similarly to what happened with LF mappings for idioms in DM, the lexical entry in (73) is specified not just for a syntactic structure, but also for morphophonological content. As we have seen in footnote 63, in DM, it would be possible to avoid referring to specific morphophonological forms by referring to numbered syntactic roots in the LF mapping. However, since Nanosyntax allows for free choice when inserting roots in nodes like N, so it seems to me that there is no way of restating (73) without making reference to phonological content, something that could be considered problematic if one believes that all the communications between PF and LF have to go through syntax.

(74)



(modified from Baunaz and Lander, 2018: 57)

2.4.4.2 The architecture of Nanosyntax

In order to understand how Nanosyntax works, it will be useful to understand how it differs architecturally from Distributed Morphology. In DM, syntactic atoms, found in List 1, can be both individual features or bundles of features. Syntactic structure is thus built from these syntactic atoms and, then, when a phase boundary is reached, the syntactic structure is sent to PF and LF to be spelled out according to the context-sensitive mappings present in List 2 (the Vocabulary) and List 3 (the Encyclopaedia) respectively. Moreover, in DM, only syntactic heads can be realised by a morphophonological form and by a meaning. Differently from DM, Nanosyntax assumes that each syntactic head can host only one syntactic feature. Moreover, only phrases (not heads) can be sent to the Lexicon to be spelled out. Indeed, Spellout is an operation that searches the Lexicon for a lexical item that matches (or is a superset of) the syntactic structure just built.[84] Crucially, Spellout occurs at every projection and already spelled out material can be substituted by new morphophonological material at higher projections (Cyclic Override). By mandating that only phrases can be spelled out, Nanosyntax can account better than DM for cases where not every syntactic head has a specific realisation or meaning, and where instead a whole stretch of structure is spelled out phonologically or has a meaning. Moreover, the use of lexical entries that only contain an L-tree and its meaning, or an L-tree and its morphophonological realisation can easily account for mismatches between LF and PF. However, Nanosyntax struggles more than DM for cases of double exponence.

Before going on, let's focus for a moment on the representational commitments of Nanosyntax. Like DM, Nanosyntax assumes that there is a distinction among syntax, meaning and form. However, instead of having three different lists like DM does, Nanosyntax assumes that there is a single list, called Lexicon, which is a repository of L-trees connected to their meanings and/or their form. Indeed, the default object in the lexicon is a triplet of syntactic structure, meaning and form, whose schematic representation is given in Figure 2.12.

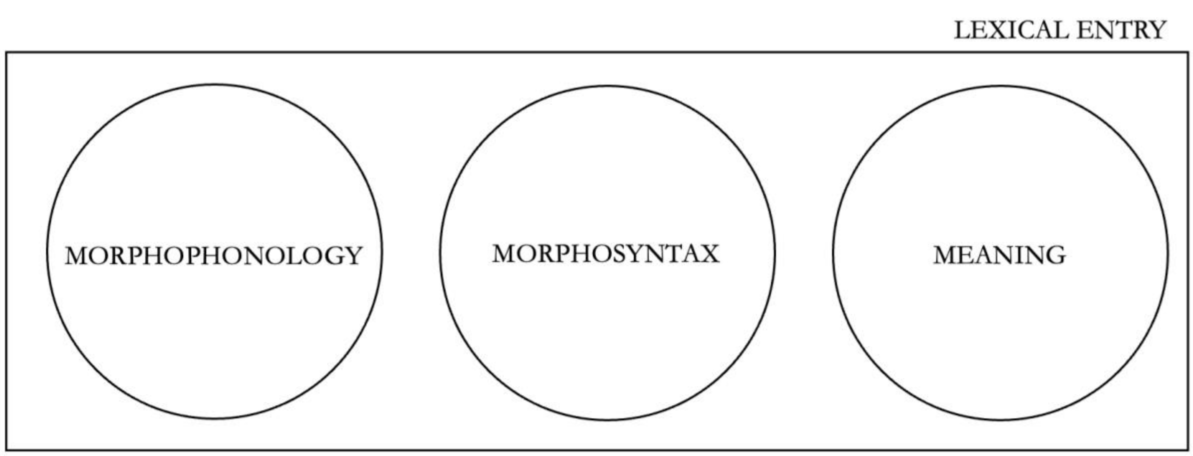


Figure 2.12: A lexical entry made up of an L-tree, its morphophonological realisation and its meaning.

Prima facie, the lexical entry in Figure 2.12 is the same as the representation of a traditional morpheme I gave in Figure 2.2. However, there are two differences between them that are not revealed by the representation in Figure 2.12. First of all, the material inside the morphosyntax circle is a fully formed syntactic phrase, an L-tree. Secondly, in traditional morphemes, the syntax, meaning and form are associated with each other *before* the syntax is built. This a-priori association makes it impossible for traditional morphemes to have contextual meanings or forms. On the other hand, since lexical entries are matched with S-trees only after the syntax has occurred, this ensures that the correct contextual interpretations and/or contextual realisations can surface. One more thing to notice about lexical entries in Nanosyntax is that, as we have seen above, they don't have to be triplets of meaning, syntax and form. Instead, they can be duplets of only syntax and meaning, as shown in Figure 2.13, or duplets of syntax and form, as shown in Figure 2.14. These 'incomplete' lexical entries are basically used to account for mismatches between the LF and the PF interfaces.

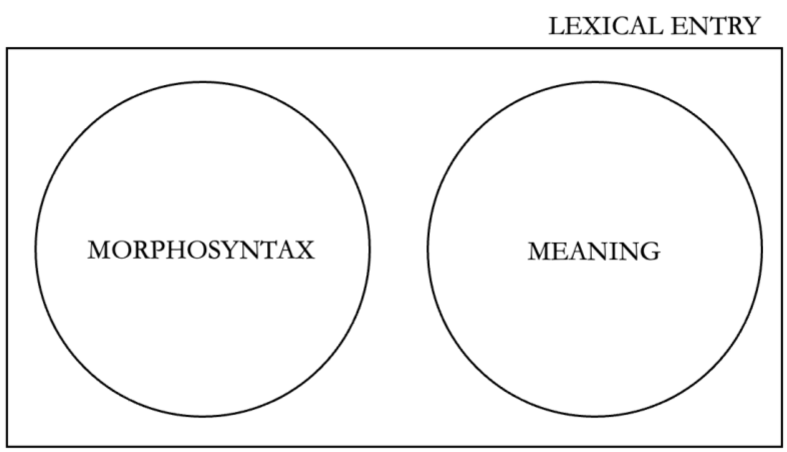


Figure 2.13: A lexical entry made up of an L-tree, and its meaning only.

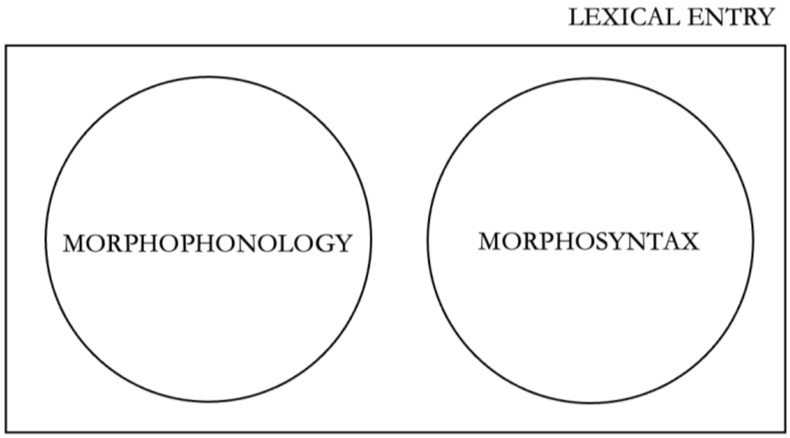


Figure 2.14: A lexical entry made up of an L-tree, and its morphophonological realisation only.

Unlike DM which had three different lists, Nanosyntax reinstates the notion of a unitary Lexicon. However, the notion of lexicon is very different between A-morphous morphology and Nanosyntax. In A-morphous morphology, the Lexicon contained not only stored lexical items, but also generated new ones since derivational Word Formation Rules apply in the Lexicon. In Nanosyntax, instead, the Lexicon is just a repository of stored lexical entries, which connect an L-tree with its meaning and/or its form. The architecture of Nanosyntax can be seen in Figure 2.15, where it's clear that syntactic structure is built and sent to Spellout, but also that already spelled out structure can be sent back to syntax to be spelled out again. [85]

[85] In Figure 2.15, we see that PF feeds the Articulatory-perceptual systems and LF Conceptual-intentional systems, following more recent developments in Minimalism. Similar assumptions could be made about all the other morphological systems reviewed here.

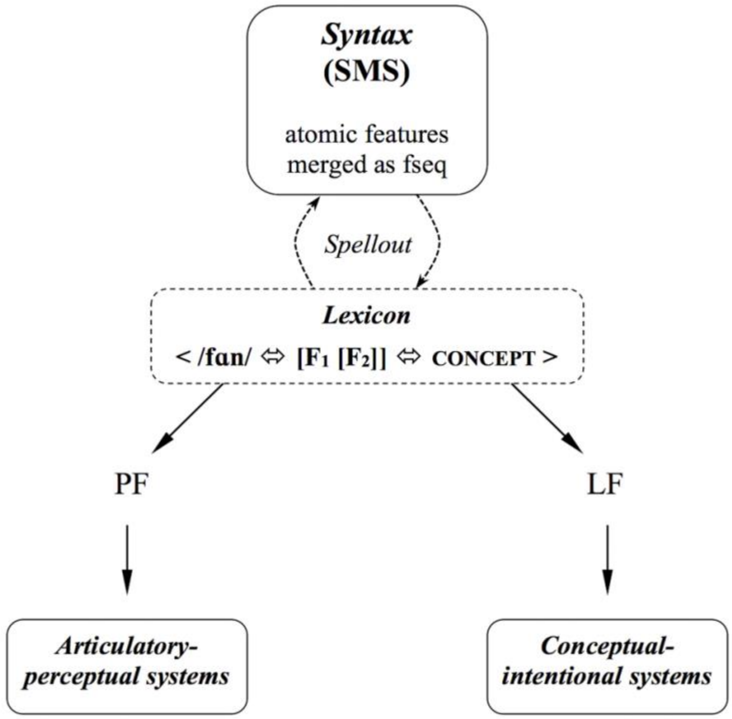


Figure 2.15: The Nanosyntax Architecture (Baunaz and Lander [2018: 26]).

2.4.4.3 Taking stock

Nanosyntax is similar to DM in that all linguistic structure is built syntactically. However, Nanosyntax maintains that phrases, not heads are spelled out. These two assumptions together with the existence of lexical items that either have no meaning or no phonological form allow Nanosyntax to account for mismatches between meaning and form. Nanosyntax can deal with morphophonological changes other than affixation (see section 2.3) by using lexical items that have a special morphophonological form, but are unspecified for meaning. Thus, Nanosyntax maintains that the locus of unexpected morphophonology can be bigger than a single syntactic atom. DM, instead, obtains the same results by having each syntactic head be spelled out by a (possibly null) morphophonological form, and at the same time allowing for neighbouring syntactic heads to influence this morphophonological form. Similarly, unexpected meanings, like those of idioms, are accounted for in Nanosyntax by having lexical items that are specified only for syntax and meaning. To account for the same data, DM uses meaning variants of a single node that are influenced by the surrounding syntactic contexts, so that technically the locus of unexpected meaning is still just one node. A summary of the model is provided in Table 2.3.

Nanosyntax	
(Q1)What are the basic elements of morphology in this approach?	Morphosyntactic features. Each morphosyntactic feature is hosted in its own syntactic head.
(Q2) What's the relation between morphology and syntax in this approach?	Morphology and syntax are one and the same thing.
(Q3) Is this a fully realisational approach?	Yes, syntactic phrases are realised by lexical items after the syntax has been built.
(Q4) How are meanings derived in this approach?	Via lexical items that link syntactic structures with meanings.

Table 2.3: Theoretical assumptions of Nanosyntax.

2.4.5 Spanning

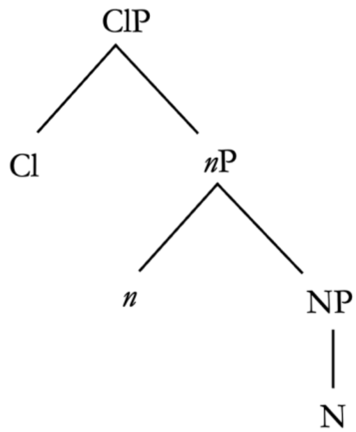
Spanning (Ramchand, 2008; Svenonius 2012, 2016) is another syntactic theory of morphology. It shares theoretical assumptions with Mirror Theory (Brody 2000a, b), which we don't review here, and DM. Moreover, Spanning practitioners tend to assume more fine-grained syntactic structures than DM, in this sense sharing assumptions with Nanosyntax. The key assumption of Spanning is that it allows for syntactic structures bigger than a syntactic node to be spelled out. Moreover, Spanning is really a theory of the interface between syntax and PF, and it is not generally concerned with the meaning interface. In what follows, I will only briefly report on Spanning and will not get into a lot of the specifics of this approach. For instance, I will not get into the difference between *w* and @, or the fact that Spellout is divided into Lexical Matching and Insertion (as shown in Figure 2.16 below). The interested reader should refer to Bye and Svenonius (2012) and Svenonius (2012; 2016) for more in-depth discussion.

2.4.5.1 How Spanning works

In Spanning, just like in DM and Nanosyntax, all linguistic structure is built syntactically. Once a phase boundary is reached, what can be lexicalised can be a head, as in DM, but also a span. A span is a series of syntactically contiguous heads, i.e., a 'sequence of heads in a head-complement relation' (Svenonius, 2016: 6). Indeed, Spanning relies on the notion of extended projection, where a lexical head is associated with a (partially or totally) ordered set of functional projections (Svenonius, 2012). Let us see an example of this. A nominal extended projection can be made of a nominal root, N, a categorising head *n*, and a classifier head, Cl, which would contain plural marking (Svenonius, 2016 based on Borer, 2005).[86] The nominal extended projection will thus be a sequence as in (75), with each higher head taking the lower head as a complement.

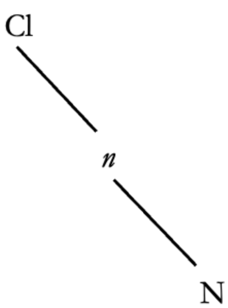
[86] In this analysis, the Cl head has the same function that the Num head had in Nanosyntax, see section 2.4.3.1. The names different analysts will give to specific heads can vary quite a bit, usually for theory-internal reasons, but what is important about different functional heads is the function they have, above and beyond the name they carry.

(75)



In Spanning, the more traditional representation in (75) is usually simplified according to the tenets of Mirror Theory, so that it appears as in (76).

(76)



Apart from the representation adopted, what matters is that Cl, *n* and N are a contiguous sequence of heads, i.e., they are a span. A single head counts as a span as well. Thus, given the structure in (75-76), we can have all the spans in (77).

(77) a. <N>

b. <n>

c. <Cl>

d. <*n,* N>

e. <*n*, Cl>

f. <N, *n*, Cl>

In Spanning, any of the spans listed in (77) can be spelled out by a morphophonological form. Let us take examples of 3 words: *pig-let-s*, *dog-s* and *mice*, to see how this works in practice. With *pig-let-s* we have an example of N, *n* and Cl all spelled out separately, as shown in (78).

(78) a. /pɪg/ ⇔ <N>

b. /lət/ ⇔ <*n*>

c. /z/ ⇔ <Cl>

(Svenonius, 2016: 9)

In *dog-s* instead, there is no separate spellout for the *n* head, so that *dog* will spell out the span <*n,* N>, as clear from (79).

(79) a. /dɔg/ ⇔ <*n,* N>

b. /z/ ⇔ <Cl>

Finally, in *mice*, where there is no overt marker for plural, *mice* will spell out the whole <N, *n*, Cl> span, as shown in (80).

(80) a. /maɪs/ ⇔ <N, *n*, Cl>

(Svenonius, 2016: 9)

In Spanning, similarly to what happened in Nanosyntax, a bigger structure than a single head can be spelled out, and this is what accounts for morphophonological changes other than affixation. Thus, Spanning, just like Nanosyntax, deals with root suppletion and root allomorphy in the same way: it is just an accident that /maʊs/ and /maɪs/ are phonologically similar.

2.4.5.2 The architecture of Spanning

Spanning allows more flexibility than either DM or Nanosyntax in what amount of structure can be spelled out. Indeed, both single heads and sequences of contiguous heads can be spans, and thus be spelled out by morphophonological forms. This allows Spanning to easily account for both cases where there is a one-to-one correspondence between a morphosyntactic feature and its spellout (the cases where DM excels), as well as cases where multiple morphosyntactic features are spelled out by a single form (the cases where Spanning excels). Since neither option (a single head or a bigger span) is more basic than the other, Spanning can do away with the theory-internal mechanisms that both DM and Nanosyntax need to account for cases that deviate from their basic assumptions. For instance, Spanning can dispense with Spellout-driven Movement, the need to spell out at every projection, or Cyclic Override, which are crucial to the correct functioning of Nanosyntax. Similarly, Spanning doesn't need operations like Fusion or post-Spellout Readjustment rules, which DM needs to account for mismatches between morphosyntax and morphophonology. However, the lack of any mechanism like Readjustment rules does force Spanning to treat root allomorphy and root suppletion in the same way.[87] While it shares assumptions with both Nanosyntax and DM, in terms of architecture, Spanning is more similar to DM, in that syntactic structure is not sent to the interfaces until a phase boundary is reached and already

[87] Just to reiterate one more time though: whether to treat root allomorphy and root suppletion in the same way or not often boils down to a matter of personal taste of the analyst.

spelled out structure is not sent back to be spelled out again. The architecture of Spanning can be seen in Figure 2.16.[88]

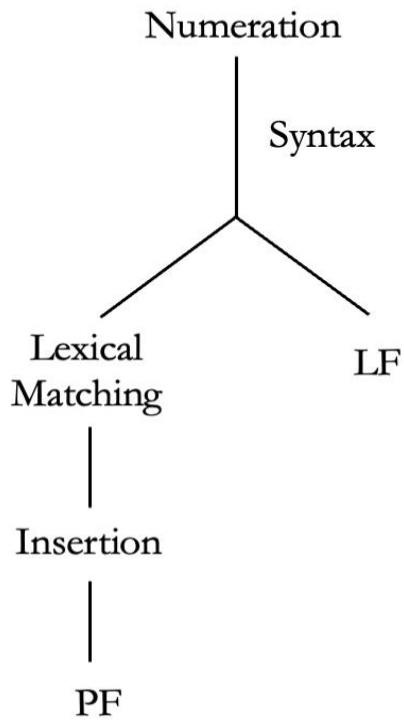


Figure 2.16: The Spanning Architecture.

2.4.5.3 Taking stock

Spanning is, above all, an exploration of morphosyntax-morphophonology interface. By deploying spans, Spanning provides a way to account for both one-to-one and many-to-one mappings between morphosyntax and morphophonology. Thus, it constitutes an alternative to both DM, with its strict requirement that only syntactic heads can be spelled out, and to Nanosyntax, where the stipulation

[88] The architecture presented in Figure 2.16 is not given in any Spanning paper. I have created it on the model of the DM architecture by making the relevant changes. Thus, Spanning practitioners might not find it as an accurate description of their own model, in which case I look forward to being corrected.

that only phrases can be spelled out results in types of movement not postulated by other theories. However, Spanning does not address other aspects of morphological theory, especially with regard to how meanings of syntactic structures are obtained. Indeed, all the representations that Spanning assumes simply contain morphosyntactic and morphophonological information, as shown in Figure 2.17.

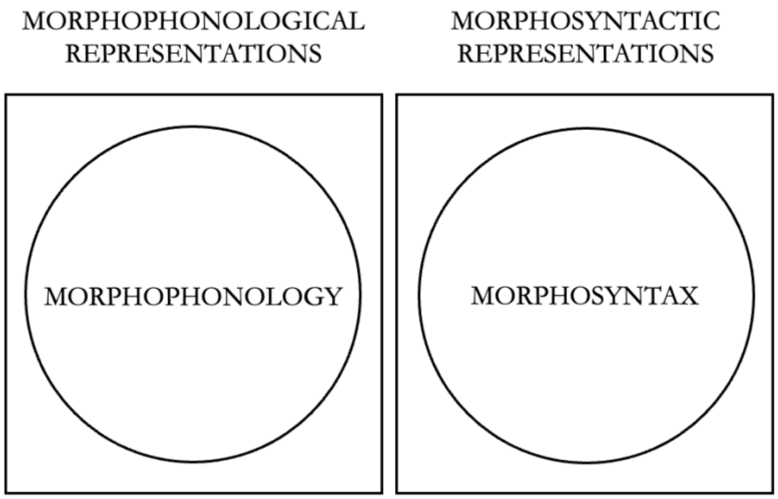


Figure 2.17: Distinct representations for morphosyntax and morphophonology.

As we will see in the next section, a model of how morphosyntax interacts with both PF and LF can be developed starting from some of the theoretical assumptions of Spanning.

Spanning	
(Q1)What are the basic elements of morphology in this approach?	Morphosyntactic features.
(Q2) What's the relation between morphology and syntax in this approach?	Morphology and syntax are one and the same thing.

(Q3) Is this a fully realisational approach?	Yes, spans are realised after the syntax has been built and a phase boundary is reached.
(Q4) How are meanings derived in this approach?	N/A

Table 2.4: Theoretical assumptions of Spanning.

2.4.6 Non-isomorphism

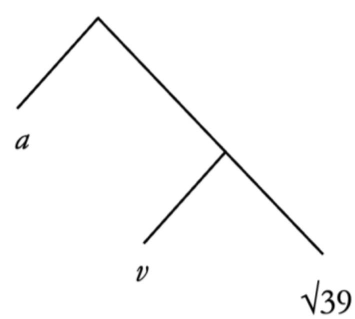
Non-isomorphism is what a theory of morphology would look like if we allowed different stretches of syntactic structure to be interpreted at PF and LF. The model sketched in this section is inspired by a series of talks and classes by Omer Preminger. I chose the term 'Non-isomorphism' to refer to it to highlight how it proposes that the amount of syntactic structure read at PF and LF is different.[89] The model sketched in Preminger (2021) uses basic DM machinery (that should by now be familiar to the reader), but argues that the amount of syntactic structure sent to PF and LF should be allowed to be bigger than just a syntactic head. Given the unpublished nature of this work, Non-isomorphism is not a fully fleshed-out theory, and there are many things that would need to be worked out in more detail if one wanted to adopt this model. However, I review it here because it is similar in spirit to Spanning, but deals with meaning too. Basically, Non-isomorphism argues that PF and LF spans are not isomorphic, and this that can easily account for the facts described in section 2.3.

[89] I decided on 'Non-isomorphism' after consulting with Bešlin (p.c.) who had proposed 'Non-isomorphic Mappings', or 'Many-to-many Mappings'. Thanks to Alexander Williams for weighing in on this question too, and noting that the observation of the facts of non-isomorphism goes back at least to Sadock (1991).

2.4.6.1 How Non-isomorphism works

In Non-isomorphism, just like in DM, linguistic structures are built from syntactic atoms, and they are spelled out at the interfaces. However, differently from DM, Non-isomorphism allows not only syntactic heads, but also bigger stretches of syntactic structure to be spelled out. What is crucial in Non-isomorphism is that the amount of syntactic structure spelled out by PF and LF doesn't need to be the same. Let us see an example of how this works in practice, by seeing how Preminger (2021) analyses *terrific*. The syntactic structure for *terrific* will be as in (80), with the syntactic root √39 merging first with the verbaliser *v* and then the adjectiviser *a*.[90]

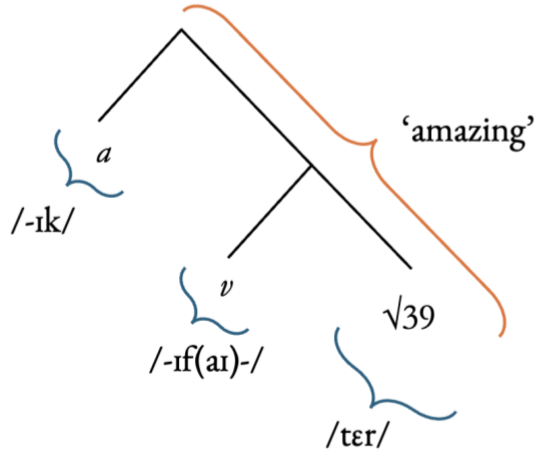
(81)



At this point, the treelet in (81) gets interpreted by the interfaces. However, crucially, the amount of structure interpreted by PF and LF is not isomorphic, as clear from (82).

[90] Even if Preminger (2021) uses a notation for root identification that seems to hint at the phonological content of roots, namely √TERR, he clearly states that roots are purely syntactic objects, with no meaning and no form. So, I substituted it with a numbered root, following Harley (2014) and the convention used here in the description of DM for the sake of internal consistency.

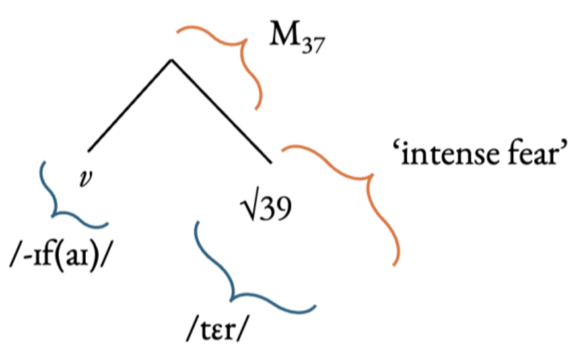
(82) [91]



(modified from Preminger, 2021: 51)

An analysis like the one in (82) allows us to maintain that *terrific* and *terrify* have the same syntactic structure, while have different meanings, as shown by (83). Preminger (2021) does not explain what the meaning of M_{37} is, but we could assume it is the meaning of the causative *v*.[92]

(83)



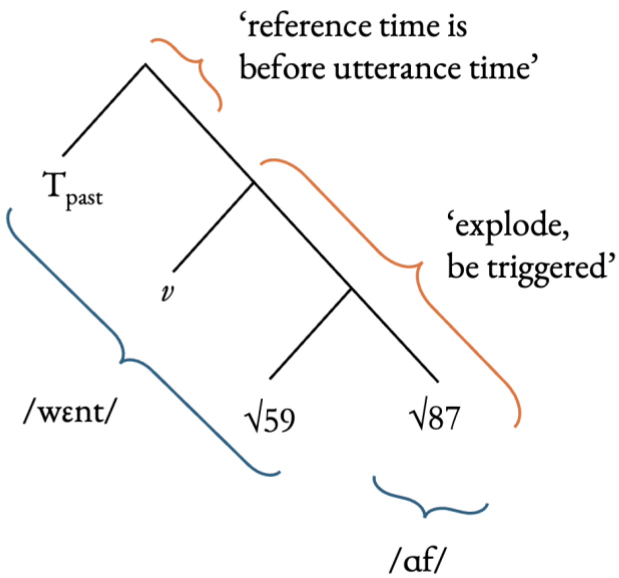
(modified from Preminger, 2021: 51)

[91] In this and the following tree, Preminger (2021) has little icons expressing the different meanings of the root √39. I use paraphrases mainly for consistency with other approaches.

[92] Preminger (2021) also does not explain how the correct allomorph of *v* is pronounced as /-ɪf-/ in (82) and as /-ɪfaɪ/ in (83). This is what would be done in DM with a Vocabulary Item that is specified for a syntactic context. However, if the curly brackets are interpreted as getting rid of Vocabulary Item in favour of syntax-to-PF mappings that refer to actual syntactic structure, some other way to ensure the choice of the correct allomorph would need to be found.

Another example of how the Non-isomorphism system works can be seen with regard to the past tense of the particle verb, *go off*, whose meaning is something along the lines of 'explode, be triggered', as shown in (84). The example in (84) is valuable in that it shows even more clearly how different amounts of syntactic structure can be spelled out at PF and LF.

(84)



(modified from Preminger, 2021: 59)

2.4.6.2 The architecture of Non-isomorphism

Non-isomorphism is not a fully developed theory of morphology, and thus there are many aspects of it that would need to be worked out in more detail. First of all, a proper theory of what kind of, and how much syntactic structure can be spelled out is not provided in Preminger (2021). Indeed, while Preminger (2021: 11-12) emphasizes that only 'contiguous' syntactic terminals can be spelled out together at the interfaces, he doesn't provide a definition of contiguity. If contiguity is defined in the same terms of Spanning theory, i.e., as a sequence of heads in a head-complement relation, then Non-isomorphism can be really just thought of as an expansion of the mechanisms of Spanning to the LF interface. There is a precursor of this idea in Nanosyntax too, where there are lexical items that are only syntax-to-PF or only syntax-to-LF mappings, instead of full triplets. However, in Nanosyntax, the default still seems to be triplets of syntax, meaning and form, an assumption that is completely absent in Non-isomorphism.[93] Non-isomorphism adopts DM stark division between syntax-to-PF and syntax-to-LF mappings, but, differently from DM, it applies it to a series of terminal nodes, and not just to a single terminal node, as shown in Figure 2.18. Indeed, Figure 2.18 is similar to Figure 2.11 given above for DM. However, the boxes indicating morphosyntactic, morphophonological and semantic representation are misaligned to make visually clear that the amount of syntactic structure spelled out at PF and LF can be different.

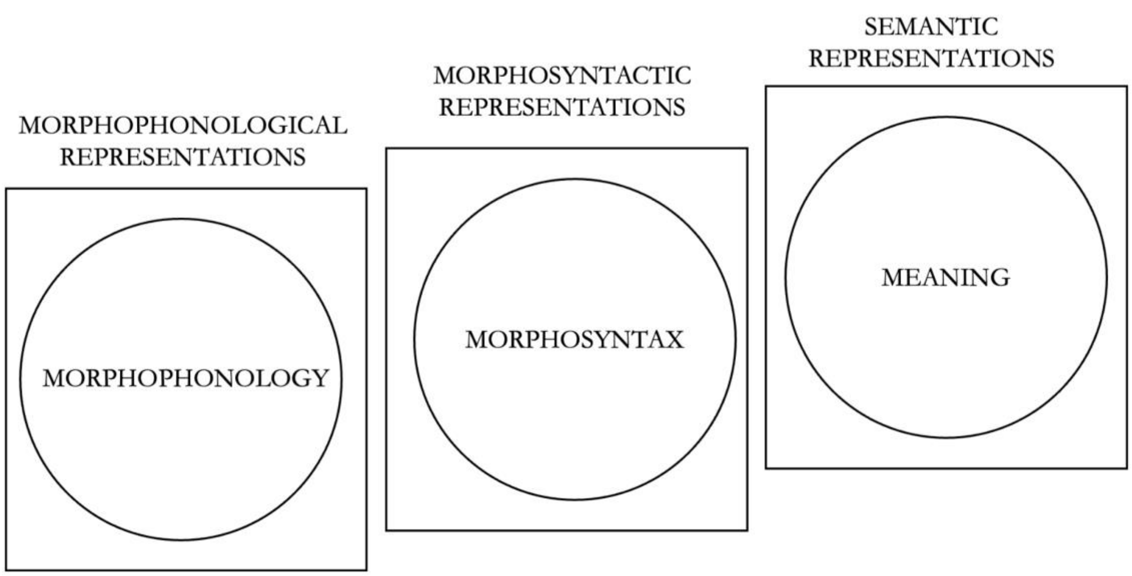


Figure 2.18: Distinct representations for meaning, morphosyntax and morphophonology.

[93] In this sense then, Non-isomorphism is a generalisation to the worst case.

Finally, Figure 2.19 provides my educated guess at what the architecture of Non-isomorphism may look like, based on its similarities and differences with DM and Spanning. I have separated the PF Spellout from the LF Spellout as a way to emphasise that different amounts of syntactic structure can be spelled out at the two interfaces.

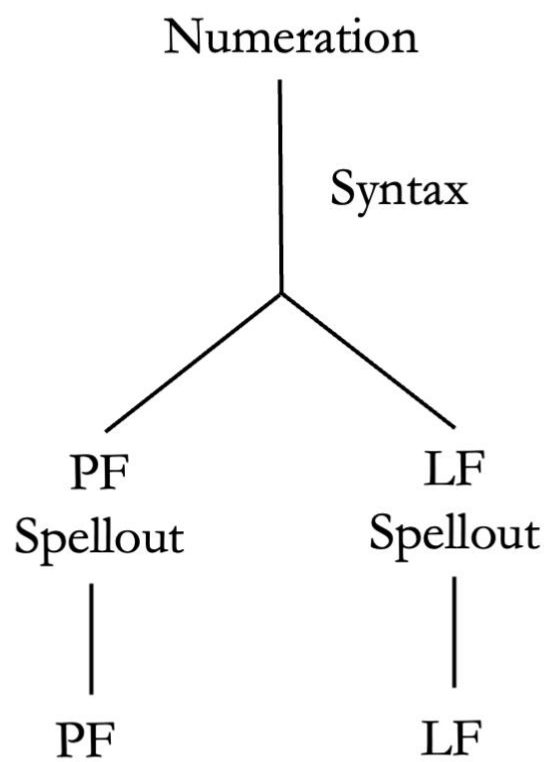


Figure 2.19: The Non-isomorphism Architecture.

2.4.6.3 Taking stock

I have reviewed Non-isomorphism here since it brings to its extreme consequences the core idea of Spanning that syntactic structures bigger than single terminals can be spelled out. However, much work would need to be done to turn it into a fully-fledged system, as well as to determine what the consequences of adopting a system like Non-isomorphism are. Table 2.5 provides an overview of this model as it stands now.

Non-isomorphism	
(Q1)What are the basic elements of morphology in this approach?	Morphosyntactic features.
(Q2) What's the relation between morphology and syntax in this approach?	Morphology and syntax are one and the same thing.
(Q3) Is this a fully realisational approach?	Yes, different stretches of contiguous syntactic heads are realised at PF and LF.
(Q4) How are meanings derived in this approach?	Via syntax-to-LF mappings that specify the contextual meaning of stretches of contiguous syntactic heads.

Table 2.5: Theoretical assumptions of Non-isomorphism.

2.5 Towards a new understanding of morphology

In section 2.4, we have reviewed five different models of morphology, namely A-morphous morphology, Distributed Morphology, Nanosyntax, Spanning and Non-isomorphism. We have looked in some detail at the different assumptions these models make and how they are implemented in practice. In this section, we will look more closely at what all of them have in common, and what this means for psycholinguistic work.

2.5.1 Morphosyntactic objects and morphophonological exponents

In section 2.4.1, we saw that morphosyntactic features are not meanings themselves, they only map to meanings. This is because, for instance, using the morphosyntactic feature plural doesn't entail talking about more than one entity (e.g., 'It is zero degrees outside.'). Similarly, using past tense doesn't necessarily mean talking about a time before now. However, as we have seen, the distinction between morphosyntactic features and their meanings is not adopted by all the morphological approaches reviewed here. The exceptions are A-morphous morphology and Spanning. The former conflates meaning and morphosyntax for lexical items (see Figure 2.7), and doesn't talk about the meaning of morphosyntactic features for inflection. Spanning simply doesn't talk about the meaning of any morphosyntactic elements. DM, Nanosyntax and Non-isomorphism instead distinguish between morphosyntactic elements and their meanings.

At the PF interface, all the approaches reviewed here, distinguish between morphosyntactic features and their morphophonological realisation. This is because the same morphosyntactic feature can be realised differently in different contexts. Let's take the example of past tense in English. In regular verbs, it is realised as /-d/ and its phonologically-conditioned allomorphs, as shown in (85a). In irregular verbs, it is realised as a vowel change, as in (85b); to which in some other cases, a suffix can be added, as in (85c).

(85) a. *played/laughed/wanted*

b. *sang*

c. *brought*

No matter what morphophonological change marks it, all of these verbs are morphosyntactically past. All the morphological approaches reviewed here recognise this by saying that what these forms have in common is that they are verbs that carry the morphosyntactic feature past.

Now that we have seen how these approaches deal with morphosyntactic features, let us think about what happens for lexical elements. Nanosyntax, Spanning, DM and Non-isomorphism all postulate syntactic roots, which are associated with their morphophonological realisations after the syntax. In DM, each syntactic node and, thus, each root, always has its own morphophonological realisation. Instead, in Nanosyntax, Spanning and Non-isomorphism, the syntactic root might not have a morphophonological realisation separate from that of the surrounding morphosyntactic structure. What is crucial though is that there is a distinction between morphosyntax and morphophonology. A-morphous morphology does not assume roots, and uses lexical items instead. As we have seen in section 2.4.2.1, lexical items are sets of semantic and syntactic properties that can be associated with multiple morphophonological forms (Anderson, 1992: 122). While Anderson (1992) is not exactly clear on how this association occurs, it is clear that he distinguishes syntactic and semantic aspects of lexical items from their morphophonological realisations.[94] Thus, it is fair to say that, even in the lexical domain, all the morphological models reviewed in this chapter postulate morphosyntactic objects, be they roots or lexical items, that are independent of a specific morphophonological realisation.[95]

[94] It worth emphasising once more that in A-morphous morphology, lexical items, *qua* Saussurean signs, have inherent meanings, differently from purely syntactic roots, which take on meanings at the LF interface. Moreover, derivation is done in the lexicon in A-morphous morphology, while it is done syntactically in all the other theories reviewed here.

[95] Probably, the only place where A-morphous morphology and the other approaches reviewed here actually differ is with regard to derived words. These would be considered as having the same root in syntactic approaches to morphology, but that would instead be considered as having different lexemes in A-morphous morphology. An example of this would be the

In a nutshell, all the morphological theories reviewed here agree in differentiating between morphosyntactic objects and their morphophonological realisations. While this conclusion has been widely recognised for functional material, especially for inflection (Beard, 1995; Marantz, 2013; Anderson and Sims, 2023 among others), the parallelism in the lexical domain is less apparent. This is because A-morphous morphology adopts lexical items, while in all the other theories reviewed here assume roots instead. However, despite the different characteristics of lexical items and roots, and despite the different ways in which they are generated, they both require a separation between morphosyntax and morphophonology.

2.5.2 Morphological consensus and psycholinguistics

It should be clear by now that the morphological consensus today is not only that we have to get rid of traditional morphemes, but also that we have to distinguish between morphosyntactic objects and their morphophonological representations. In psycholinguistics work, this means that we should give up looking for evidence of morphemes, and instead try to determine whether our experimental measures are more sensitive to morphosyntactic features or to their morphophonological representations.

Indeed, getting rid of morphemes does not mean assuming there is a direct connection between meaning and form, as argued in Baayen et al. (2011). Baayen et al. (2011) takes Anderson's (1992)

adjective *lovable*, which, in syntactic approaches to morphology, has the same syntactic root of *love*. In A-morphous morphology, instead, *lovable* is derived from *love* via a Derivational Word Formation rule, and thus constitutes its own independent lexeme. Even then though, some way might be found to state that two forms have the same original lexeme in common. In practice, in this dissertation, no experiments investigate priming between two words derived from the same root/original lexical item, so this problem doesn't come up.

rejection of morphemes, and his postulation of lexical items, as a theoretical motivation for dispensing of any level mediating between meaning and form in morphology. However, as should be clear from the previous section, while A-morphous morphology argues for the existence of lexical items (or lexemes), it does not get rid of a morphosyntactic level of representation. The claims made here are not completely new. For instance, Marantz's (2013) response to Baayen et al. (2011) makes similar points to what is argued here. However, many of the works in that vein are directly inspired by DM theorising, and thus use the term '(abstract) morpheme' to refer to syntactic nodes. This terminological choice, which uses an old term with a new meaning, has obscured the general agreement that there is, among various theories of morphology, about the distinction between morphosyntactic objects and their morphophonological realisations. The discussion in this chapter has been an attempt to avoid using a theory-specific terminology and to highlight the general consensus in current theories of morphology, while also providing a nuanced understanding of the important differences among them. Hopefully, the time taken here to do so will provide us with a strong basis to do experimental work that is informed by current theoretical views in morphology, and that nevertheless shuns away from adopting a specific framework. Indeed, the present discussion should have shown how, at the level of abstraction we are interested in, the degree of agreement among the various theories is actually quite impressive.

2.6 Conclusions

This chapter has covered a lot of ground. First of all, we looked more closely at what the traditional notion of morphemes entails. Secondly, we have seen how this notion cannot appropriately account for a variety of morphological facts in the world's languages. The following sections were dedicated to reviewing five morphological theories, namely A-morphous Morphology, Distributed Morphology, Nanosyntax, Spanning and Non-isomorphism. While these theories differ, sometimes even radically among themselves, they all agree we must distinguish morphosyntactic objects from their morphophonological realisations. What are the consequences of this conclusion for psycholinguistics? Instead of looking for evidence of morphemes (or lack thereof), we should try and separate the contributions of morphosyntactic features from their morphophonological realisations.

The next chapter will be dedicated to reviewing some of the established results in the morphological priming literature, and understanding how we might re-interpret them in light of the insights gained in this chapter. Later chapters, instead, will propose experiments to try and disentangle morphosyntactic objects from their morphophonological realisations. For the sake of convenience, in the rest of this dissertation, I will assume that all morphosyntactic structure is built syntactically, and that there is a distinction between syntactic objects, their meanings and their morphophonological realisations even though this is not shared by every theory reviewed here.

Chapter 3

Re-evaluating morphological priming experiments

3.1 Introduction

In Chapter 2, we saw how the notion of 'morpheme', as the smallest unit of form with a meaning, has been widely abandoned by morphologists, and how it has been substituted by a realisational view of morphology, where we distinguish morphosyntactic objects from their morphophonological realisations. In the psycholinguistics literature, priming has been used to investigate morphological relatedness between words. However, if we abandon the traditional notion of morphemes, how should we interpret priming results that argue to have found 'morphological' priming? This chapter provides a re-evaluation of existing experimental results in view of the theoretical developments reviewed in Chapter 2.

3.2 Some notes on priming

Before getting into the interpretation of priming results, it will be useful to quickly review how the priming paradigm works. In a priming experiment, participants are presented first with a prime, and then with a target. After the target is presented, participants are required to respond to the target in some way, as shown in Figure 3.1. The kind of response required will depend on the experiment, but most priming experiments investigating morphological relatedness are lexical decision tasks, i.e., experiments where some (generally half) of the items are real words and the remaining items are non-words, and participants are asked whether the item they just saw (or heard) is a real word or not. Since a response is provided only after the target, this is sometimes referred to as paired priming paradigm (i.e., a response is given after the prime-target pair).

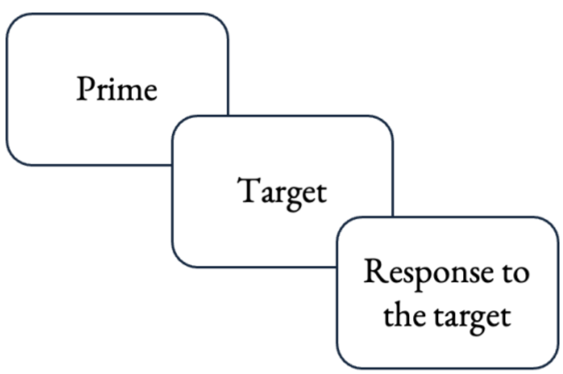


Figure 3.1: Paired priming paradigm.

In priming experiments, researchers manipulate some aspect of the prime in order to determine something about the the target. Indeed, the same target is usually paired with different primes in different conditions. Comparison between response times to the same target when preceded by a related or an unrelated prime is what researchers look at to determine whether there is a priming effect or not. If participants respond to a target preceded by a related prime significantly faster than they do to the same target preceded by an unrelated prime, we say that there was a priming effect. Many forms of relatedness have been investigated with priming. For instance, researchers have looked at so-called 'identity priming', i.e., whether there is a priming effect when the prime is the same word as the target (e.g., *doctor* → *doctor*). Semantic effects of priming between words that are related in meaning (e.g., *nurse* → *doctor*) have also been widely investigated. Moreover, as we will see in the rest of this chapter, various kinds of morphological relatedness have also been investigated. Even if a great deal of work has used the priming paradigm to try and get at linguistic representations, we still know very little about what exactly triggers priming or what the mechanisms behind it are (Neeley et al., 1989; Pickering and Ferreira, 2008; Schacter and Buckner 1998 among others).

Many factors modulate priming effects, such as mode of presentation, relatedness proportion, non-word proportion and experimental design. For instance, the prime can be masked, i.e., presented for a very short time and preceded by a forward mask (usually a string of ########), such that it is not consciously perceived. In masked priming experiments, the effect of semantic similarity, which is usually found in unmasked paradigms, is absent or extremely reduced (see Amenta and Crepaldi [2012] and Marelli et al. [2020] for useful overviews). Moreover, studies by Marslen-Wilson and his group using the same materials but with different presentation modality (auditory vs visual) highlight how the latter influences priming results (Boudelaa and Marslen-Wilson, 2004 among others). A series of studies have also shown that relatedness proportion influences the amount of semantic priming (Seidenberg et al., 1984; Neeley et al., 1989 among others). Others characteristics of experimental items also have an effect on priming: frequency (e.g., Giraudo and Grainger, 2000; Meunier and Segui, 1999; Raveh, 2002 among many others), target word neighbourhood (Forster and Taft, 1994; Schreuder, 1997 among others), and family size (e.g., Bertram et al., 2000a; Juhasz and Berkowitz, 2011; Pylkkänën et al., 2004; Schreuder, 1997).

In a nutshell, while priming has been widely used to investigate various aspects of linguistic representations, it is still unclear why priming effects should ensue at all. First of all, mental computations could have worked in the opposite way from what we see, and being presented with a related representation could have slowed down (instead of facilitated) the processing of the target.[96] Secondly, while the number of EEG, MEG and MRI studies using priming grows by the day, very little is still known about the brain mechanisms underlying it (see Leminen et al., 2019). In other words, we can use priming as a diagnostics to try and get at linguistic representations, but priming is just a tool (and not a very refined one at that).

Different theories have been put forward to explain priming effects. For some theories, priming reflects an associative link between prime and target (Collins & Loftus, 1975). In contrast, Bayesian interpretations of priming hold that the cause of priming is greater prior expectation for the target based

[96] In production studies using priming, some such cases are attested. Indeed, in production, semantic primes tend to slow down the production of related targets, while phonological ones to facilitate it (see e.g., Damian and Martin, 1999). However, many factors - such as when the prime is presented in relation to the target (Stimulus Onset Asynchrony), type of semantic relatedness, or whether the prime is a word or a picture - influence whether there is facilitation or inhibition (Costa et al., 2005; Damian and Bowers, 2003; Mahon, 2007; Python et al., 2018; Vigliocco et al., 2004). This goes to show once again how little we know about priming.

on the context (e.g., Norris & McQueen, 2008; Norris & Kinoshita, 2008). Other work distinguishes priming mechanisms in 'explicit' memory vs. 'implicit' memory (Graf & Schachter, 1985). Some researchers of structural priming (priming from one sentence structure to another) have suggested that it involves long-lasting adaptation that could be considered implicit learning (Chang et al., 2012). For this dissertation, I will avoid making any mechanistic assumptions about why priming occurs. Instead, I will just assume that priming reflects relatedness between prime and target. More specifically, I adopt a representational view of priming, where priming effects are understood as being due to the fact that prime and target share some aspect of their representation. Given the shared representation between prime and target, we can use priming to make deductions about the linguistic representation of the target.

It is also important to notice that our knowledge of what triggers priming effects is patchy: while a great deal of work has investigated semantic effects, much less is known about phonological priming. Thus, when using the priming paradigm, we should be reminded that we do not know what linguistic representations it is sensitive to, and that being clear about the representation we are after is crucial in making the right deductions about what priming is 'picking up'. Finally, it could very well be that there are forms of linguistic relatedness that priming is not sensitive to. In the next section, we will zoom in on cases of 'morphological' priming that have been identified in the literature, and subsequently re-evaluate them in light of the analytical insights of Chapter 2. Indeed, clarifying what representations priming is sensitive to is crucial to understand what priming can and cannot tell us about linguistic representations.

3.3 Morphological priming[97]

Priming experiments have been by far the most widely used tool to investigate 'morphological' representations in the psycholinguistic literature. The first phase of this literature revolved around the question of whether full words are listed in the lexicon (e.g., Butterworth, 1983; Henderson et al., 1984) or whether their constituent morphemes are (e.g., Taft, 1981; Taft & Forster, 1975). In this phase, finding morphological priming would thus be considered evidence against full-listing accounts and in favour of morphological ones. Once morphological priming effects were established, the debate changed, now focusing on whether we need explicit morphemic representations to account for these effects (e.g., Marslen-Wilson et al., 1994; Taft, 2004) or whether they can be accounted for by simply assuming (more or less) complex relations between form and meaning (e.g., Baayen et al., 2011; Gonnerman et al., 2007; Plaut and Gonnerman, 2000; Seidenberg & McClelland, 1989). In this section, I briefly review 'morphological' priming effects as reported in the literature, while in the next section, I will explore how we can understand them in view of the theoretical developments explored in Chapter 2. Since under the rubric of 'morphological' priming researchers have made a distinction between root priming and affix priming, we look at them in turn.

[97] In the priming literature, 'morphological' priming is sometimes used to refer to what I call 'root priming', and more specifically priming from an inflected prime (*played*) to an uninflected target (*play*). Here, I use it in the more literal sense of 'priming of morphemes'.

3.3.1 Root priming[98]

In root priming experiments, researchers intend to determine whether two words that share the same root prime each other and, moreover, if there are any restrictions on the conditions under which root priming ensues. In the experimental literature, root is not usually openly defined, but it is usually intended in the traditional sense of the essential morpheme in a word, to which all other morphemes are then added. For instance, in English, words like *govern-or* and *govern-ment* share the root *govern*. Thus, a root priming experiment will try to determine whether participants are faster at responding to *govern-ment* after they have been exposed to *govern* or *govern-or* (see e.g., Crepaldi et al., 2010; Kielar et al., 2008; Marslen-Wilson et al., 1994; Rastle et al., 2004; Meunier and Marslen-Wilson, 2004; Pastizzo and Feldman, 2002; Stockall and Marantz, 2006 among many others).

Let us quickly review a root priming experiment to see how this works in practice. Root priming experiments have been carried out in multiple languages, among which Semitic languages. In the traditional view of Semitic morphology adopted in these studies, the root is a discontinuous morpheme that gets interleaved with different templates (see Chapter 2 section 2.3.1.4). Therefore, root priming experiments on Semitic test whether two words with the same root but different templates prime each other. In Experiment 2 of their paper, Frost et al. (1997) test how much facilitation there is when prime and target are identical and when they share only a root, comparing these conditions to a baseline where prime and target share letters that do not constitute a root, as shown in Table 3.1.[99] With this experiment, Frost et al. (1997) intend to determine whether two words, in this case *tizmoret* 'orchestra' and *zamar*

[98] Root priming is also sometimes referred to as stem priming.

[99] This experiment was a masked visual priming experiment where the prime was shown for 43ms. 48 participants took part in it.

‘singer’ which share the root *z-m-r* (related to playing instruments) prime each other, compared to an orthographic control condition where prime and target share three letters (in this case, *t*, *m* and *r*), but not a root.

	Prime	**Target**	**RT**
Identity	*tizmoret* (TZMWRT) ‘orchestra’	*tizmoret* (TZMWRT)	566ms (-25ms)
Root	*zamar* (ZMR) ‘singer’	*tizmoret* (TZMWRT)	578ms (-13ms)
Unrelated	*tamar* (TMR) ‘date’	*tizmoret* (TZMWRT)	591ms

Table 3.1: Experimental conditions in Frost et al. (1997) - Experiment 2, Hebrew. Uppercase characters between brackets are the transliteration of the Hebrew characters the participants actually saw (W stands for the Hebrew letter waw). The root of the target is *z-m-r*. Root overlap is shown in blue, orthographic overlap in green. RT reports the response times, between brackets there is the difference between the condition under consideration and the control.

Frost et al. (1997) identify significantly faster responses in both the Identity and the Root conditions compared to the Unrelated condition. The faster response in the Root condition is taken as evidence that prime and target share a morphological representation, namely the root morpheme. In other words, Frost et al. (1997) interpret their experimental results as evidence that root morphemes are openly represented in the lexicon of Hebrew.

Similar experiments in other languages have identified similar root priming effects. Just to cite an example from English, Marslen-Wilson et al. (1994) show that root priming is found even between different allomorphs of the same root (e.g., *elusive* → *elude, serenity* → *serene*). Indeed, root priming effects have been identified in multiple languages and multiple modalities, and have been widely replicated in the morphological priming literature (see Amenta and Crepaldi, 2012 and Marelli et al., 2020 for overviews).

3.3.2 Affix priming

While the majority of studies on morphological priming focus on roots, a handful of them investigate affix priming. Similarly to what happens for root priming, the idea behind affix priming is to determine whether sharing an affix (be it derivational, e.g. *-ity*, or inflectional, e.g., the plural *-s*) engenders priming. Thus, the idea is to see whether the response to a target like *equal-ity* is faster after a prime that has the same affix, e.g., *brev-ity*, as opposed to an unrelated prime. An example of this is found in Experiment 3 in Duñabeitia et al. (2008), who investigated the priming effects of the Spanish derivational suffix *-dad*.[100] This affix, just like its English counterpart *-ity*, turns adjectives into nouns.

	Prime	**Target**	**RT**
Related	*brevedad* (brevity)	*igualdad* (equality)	761ms (33ms)
Unrelated	*plumaje* (plumage)	*igualdad* (equality)	794ms

Table 3.2: Experimental conditions in Duñabeitia et al. (2008) - Experiment 3, Spanish. RT reports the response times, between brackets there is the difference between the related and unrelated condition.

Duñabeitia et al. (2008) found that participants are significantly faster after a related than unrelated prime, and thus interpret these results as evidence that the shared morpheme *-dad* caused priming. It is

[100] This experiment was a masked visual priming experiment where the prime was shown for 50ms. 28 participants took part in this experiment.

worth noting that evidence for affix priming is less robust than for root priming (see e.g. Cho et al., 2024; Crepaldi et al., 2016; Gaston et al., 2021; Giraudo and Grainger, 2003; Goodwin Davies and Embick, 2019)

3.3.2 Interpretations of 'morphological' priming

Evidence for morphological priming coming from both root priming and affix priming has been interpreted in different ways by different scholars. Some scholars (e.g., Frost et al., 1997; Marslen-Wilson et al., 1994; Taft, 2004 among many others) have taken them as evidence that morphemes, as the smallest units of form with a meaning, are explicitly represented in the mental lexicon, and thus guide language comprehension. Other scholars, instead, have argued that the same results would be due to finely tuned connections between meanings and orthographic/phonological forms that can simulate morphological effects without overtly representing morphemes (Baayen et al., 2011; Gonnerman et al., 2007; Plaut and Gonnerman, 2000; Seidenberg & McClelland, 1989). However, if the theoretical advancements in analytical morphology we have seen in Chapter 2 are on the right track, neither interpretation is viable. This is because contemporary morphologists maintain that we should move away from the traditional notion of morphemes, but also argue against a direct mapping between meaning and form. The question thus arises as to how to make sense of these priming results. The next section is dedicated precisely to that.

3.4 Re-evaluating 'morphological' priming

In Chapter 2, we saw how the traditional notion of morphemes, as the smallest units of form with meaning, has been abandoned in analytical morphology. Thus, the challenge that we are now faced with is understanding what causes 'morphological' priming effects that we see in psycholinguistic experiments. As we saw in Chapter 2, it is necessary to distinguish between a morphosyntactic object, its morphophonological realisation and its meaning, as shown in Figure 3.2.

Figure 3.2: The distinction between meaning, morphosyntax and morphophonology.

What does this mean for 'morphological' priming? Let's think back about the *governor/government* case. In the traditional view of morphology, these two words share the root morpheme *govern*, which has the phonological form /gʌvərn/ and whose meaning has something to do with the ruling of people. Instead, in a realisational morphology view like the one adopted here, a purely syntactic root, let's say √77, is associated with a morphophonological realisation /gʌvərn/ and with a meaning related to the ruling of people. If we now think about this in terms of priming, if we see a priming effect going from *governor* to *government*, it could be due to the morphosyntactic root, its morphophonological realisation or its meaning. More in general, each time we see a 'morphological' priming effect, it could be due to the following reasons:

a. sharing a morphosyntactic object;
b. sharing a morphophonological form realising that morphosyntactic object;
c. sharing a particular semantic interpretation of that morphosyntactic object.[101]

Many of the existing experiments were not meant to distinguish among these possibilities, so they do not usually allow us to tease them apart. However, some of the existing experiments were designed to disentangle among different possible sources of priming, and thus can help shed light on what level of representation is causing the priming effects we see.

3.4.2 Zooming in on possible causes of priming

In order to determine what level of representation is causing priming, we have to look for mismatches between morphosyntax, morphophonology and semantics. Let's start with morphosyntax-meaning mismatches. As we have seen in Chapter 2 (section 2.3.3.2), the same root can have different meanings in different contexts. For instance, the morphosyntactic root, let's call it √39, which is realised as /kɑnsərt/ in English, has different meanings in words like *concert* and *concerted*. This fact has been used in the literature to better understand the contribution of meaning to morphological priming.

[101] It is worth noting that when psycholinguists working in the DM tradition (e.g., Marantz, 2013 among others) talk about 'morphological' priming, they are actually mean morphosyntactic priming. This is because, as we have seen in Chapter 2, in DM the term '(abstract) morpheme' stands for morphosyntactic node. Thus, their arguments are not too dissimilar from the ones made here. However, in my opinion, moving away from the terms 'morpheme' and 'morphological' makes this point come across more clearly, and avoids unnecessary confusion.

Indeed, since semantic priming effects (e.g., *nurse* → *doctor*) are independently attested in the literature, psycholinguists wanted to determine whether morphological priming is just due semantic similarity or is found independently of it (see Marslen-Wilson et al., 1994; Frost et al., 1997, 2000; Boudelaa and Marslen-Wilson, 2004; Creemers et al., 2020 among many others).

Let us see an example of this in practice. In their Experiment 5, Frost et al. (1997) test whether morphological priming of Hebrew roots is still found even when the meaning of the root is different in the prime and in the target. As clear from Table 3.3, the Hebrew words *taklit*, *haklata* and *klita* all have the same root, namely *k-l-t*, but the meaning of *klita* 'absorption' is different from that of *taklit* '(a) record' and *haklata* '(a) recording'. Thus, by testing whether *klita* 'absorption' primes *taklit* '(a) record' to same degree of *haklata* '(a) recording', Frost et al. (1997) are trying to test whether root priming is found above and beyond semantic similarity. Moreover, Frost et al. (1997) have an orthographic/phonological control, namely *takala*, to determine how much facilitation there is for sharing the three consonants as opposed to just three other consonants.[102]

Frost et al. (1997) find statistically significant facilitation in the Identity condition and in both the Morphological conditions, *irrespective* of semantic similarity.

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[102] Frost et al. (1997) are going at such great length to show that a 'morphological' representation is needed above and beyond semantic and phonological ones because they are arguing against various scholars that claim that 'morphological' effects can be reduced to similarity in form and meaning (e.g., Baayen et al., 2011; Gonnerman et al., 2007; Plaut and Gonnerman, 2000; Seidenberg & McClelland, 1989).

	Prime	Target	RT
Identity	taklit (TQLIΘ) 'a record'	taklit (TQLIΘ) 'a record'	546ms (-37ms)
+M+S	haklata (HQLΘA) 'a recording'	taklit (TQLIΘ) 'a record'	568ms (-15ms)
+M-S	klita (HQLΘA) 'absorption'	taklit (TQLIΘ) 'a record'	572ms (-11ms)
Control	takala (TQLA) 'malfunction'	taklit (TQLIΘ) 'a record'	583ms

Table 3.3: Experimental conditions in Frost et al. (1997) - Experiment 5, Hebrew. Uppercase characters between brackets are the transliteration of the Hebrew characters the participants actually saw (Q stands for the Hebrew letter qof and Θ for tet). The root of the target is *k-l-t*. Root overlap is shown in blue, orthographic overlap in green. RT reports the response times, between brackets there is the difference between the condition under consideration and the control.

We can use Frost et al.'s (1997) experimental manipulation to think more closely about what representations are shared between primes and targets in this experiment. Table 3.4 shows what each of the primes has in common with the target *taklit*. While *taklit* and *haklata* share the morphosyntactic root, its morphophonological realisation and its meaning, *taklit* and *klita* share the first two representations but not the meaning one. *Takala*, instead, while being phonologically very similar to *taklit*, doesn't share any.

		Morphosyntax	Morphophonology	Meaning
Target	***taklit***	√32	*k-l-t*	Related to 'recording'
+M+S prime	*haklata*	✓	✓	✓
+M-S prime	*klita*	✓	✓	X (unrelated to recording)

Control	*takala*	X (√59)	X (*t-k-l*)	X (unrelated to recording)

Table 3.4: Morphosyntactic, morphophonological and semantic representations shared across primes and targets in Frost et al. (1997) - Experiment 5, Hebrew. ✓ indicates identity between prime and target, while X indicates a difference between the two.

Thus, an experimental setup like the one in Frost et al. (1997) - Experiment 5 allows us to test whether words with the same morphosyntactic root but different meanings prime each other, and the results clearly show that that's the case. Moreover, they show that a 'morphological' priming effect is found only when prime and target share the three root consonants, and not any other three consonants. While this orthographic/phonological manipulation helps us exclude a purely orthographic/phonological origin of the priming, the experimental manipulations in Frost et al. (1997) do not allow us to adjudicate between a morphosyntactic or a morphophonological origin of the priming. In other words, root priming in this experiment could be due to the fact that prime and target share a morphosyntactic root, or to the fact that they share its morphophonological realisation.[103]

This excursus into a single experiment should have helped clarify the difficult task we are after. In order to determine what's causing 'morphological' priming, we have to carefully disentangle morphosyntactic, morphophonological and semantic sources of priming. The only possible way of doing this is to identify cases where a single morphosyntactic object is realised by different morphophonological forms, and/or has different meanings. While meaning manipulations have been

[103] See Cuonzo (2023) for a thorough examination of how to interpret 'morphological' priming effects in Semitic languages given recent analytical developments in the study of these languages.

attempted multiple times in the literature (see e.g., Boudelaa and Marslen [2004] for Arabic, Creemers et al., [2020] for Dutch, and Marslen-Wilson et al., [1994] for English),[104] distinguishing a morphosyntactic vs. morphophonological origin of the priming is much more difficult, especially with roots. The next section is devoted to exploring these possibilities.

3.4.3 Disentangling morphophonology and morphosyntax

Disentangling morphosyntactic and morphophonological origins of priming proves to be more difficult than separating out semantic contributions, especially in the lexical domain. This is because, as we have seen in Chapter 2 (section 2.3.2.5), within a language there are very few morphosyntactic roots that are actually suppletive, i.e., that have two (or more) completely different morphophonological realisations of the *go* ~ *went* type in English (Hippisley et al., 2004). Cases of root allomorphy, where the two morphophonological realisations of the morphosyntactic root are at least partially phonologically similar to each other (*sing* ~ *sang*), are much more widespread. As we have seen in Chapter 2, there is debate in the literature on whether cases of root allomorphy should be treated in the same way as root suppletion or not. For instance, in standard DM, root suppletion is understood as involving a morphosyntactic root with two different morphophonological realisations. Instead, root allomorphy is understood as involving not only as a single morphosyntactic root but also as a single morphophonological realisation which is then modified by Readjustment rules. If that's the correct

[104] While Boudela and Marslen-Wilson (2004b) and Creemers et al. (2020) find 'root' priming irrespective of meaning similarity, Marslen-Wilson et al. (1994) find that in English 'root' priming is strictly dependent on meaning similarity.

analysis of this phenomenon then, in the domain of roots, it is very difficult to find ways to separate the morphosyntactic root from its morphophonological realisation since we could rely only on root suppletion cases. Moreover, other frameworks (like A-morphous morphology, Nanosyntax, Spanning and Non-isomorphism) would treat root allomorphy and root suppletion in the same way: a single shared morphosyntactic object with different morphophonological realisations (which could realise more than a single morphosyntactic object). In those frameworks then, it would be impossible to separate experimentally the contributions of morphosyntax and morphophonology in the domain of roots. Chapter 5 will explore in more detail a case of root allomorphy in Italian, and its consequence for disentangling morphosyntactic priming from morphophonological one.

On the other hand, affix suppletion, especially among inflectional affixes, is much more widespread than root suppletion. In these cases, we have the same morphosyntactic feature(s) realised by different morphophonological forms. For instance, in English the morphosyntactic feature plural is realised as /-z/ for regular nouns, /-ən/ in *oxen*, /-ə/ in *bacteria* and ∅ in *fish*. Suppletion of this kind allows us to test separately for morphosyntactic and morphophonological priming. Let us see how this would work in practice. Imagine the target is a plural noun like *dolls*. The prime would be in one case another regular plural, such as *chairs*, and in another condition it would be *bacteria*. If we see priming both in the prime target pair *chairs* → *dolls* and in *bacteria* → *dolls*, we would have evidence that priming is due to sharing the morphosyntactic feature plural and not a specific morphophonological realisation of this feature, as should be clear from Table 3.5. However, from an experimental point of view, the case of plural in English is not ideal because /-z/ is by far the most common realisation of plural. In Chapter

4, we will see a case of affix suppletion in Hebrew that allows us to get at this question, and disentangle morphosyntax from morphophonology.[105]

		Morphosyntax	**Morphophonology**	**Meaning**
Target	***doll-s***	plural	/z/	‘more than one’
+MSyn +MPhon	*chair-s*	✓	✓	✓
+MSyn -MPhon	*bacteri-a*	✓	X (/-ə/)	✓

Table 3.5: Morphosyntactic, morphophonological and semantic representations shared across plural primes and targets in a potential priming experiment.

Another way of testing whether it is morphosyntax or morphophonology to engender a priming effect is to use a case where two morphophonological pieces are accidentally the same despite realising different morphosyntactic objects. Goodwin Davies and Embick (2019)[106] have an experimental design that is very close to what would be needed to get at this question. They are testing whether the morphosyntactic feature plural can be primed above and beyond the fact that regular plurals in English

[105] White et al. (2024) investigate auditory priming for the *-ing* suffix in English across two possible phonological realisations, namely *-ing* and *-in'*. However, there is debate in the literature on whether this is a case of suppletion or of allomorphy. Thus, their results cannot unequivocally adjudicate between a morphosyntactic and a morphophonological origin of the priming. See Chapter 4 for more on this.

[106] This is an auditory priming experiment with a continuous lexical decision task. 200 participants took part in this experiment.

end in /z/. To get at this question, they compared two conditions to an unrelated control, as clear from Table 3.6. In the Plural condition, the prime was syntactically plural and ended in /z/, while in the Phonological condition the prime just ended in /z/ without being plural. Goodwin Davies and Embick (2019) find a reliable priming effect only in the Plural condition. In Chapter 6, I conduct a similar experimental comparison using a case of accidental homophony between two different affixes in Italian, which makes it possible to more closely match primes in their morphophonological complexity.

	Prime	**Target**	**RT**
Plural	*crimes*	*trees*	990ms (-28ms)
Phonological	*cleanse*	*trees*	1013ms (-5ms)
Control	*crime*	*trees*	1018ms

Table 3.6: Experimental conditions in Goodwin Davies and Embick (2019), English. RT reports the response times, between brackets there is the difference between the condition under consideration and the control.

The experiments carried out in this thesis aim at separating out morphosyntactic and morphophonological origins of priming, and do so by finding mismatches between morphosyntax and morphophonology in the world's languages in both the affixal and the lexical domain. Before moving on, it is important to define how I will use the terms 'root' and 'affix'. In line with terminological choices made in Chapter 2, I use 'root' to refer to the DM-style morphosyntactic object that is devoid of meaning and form. Thus, I will talk about the difference between roots and their morphophonological realisations. On the other hand, by 'affix' I mean the morphophonological exponent of a functional syntactic head. Of the theories reviewed in Chapter 2 that assume roots, only some authors in DM, namely Borer (2005a, 2005b, 2013) and Embick (2015), posit a theoretical distinction between roots and affixes. In this dissertation, I mainly use the distinction between roots and affixes for expositional purposes, and I leave it to further research whether this distinction has theoretical foundations or not.

3.5 Rethinking comprehension

Moving away from traditional morphemes in psycholinguistics also means rethinking how comprehension works. If traditional morphemes are assumed, lexical decision is basically a process of 'morpheme spotting'. In other words, when presented with a word, comprehenders would first identify morpheme boundaries, and then build the meaning of the word as a sum of the meaning of the component morphemes. Under this view, lexical decision would entail recognising a phonological or orthographic string as a licit combination of existing morphemes.

However, if we dispense with traditional morphemes, this can't be the process that underlies comprehension. Instead, comprehension would consist in a process whereby comprehenders infer morphosyntactic structure from the morphophonological forms they hear (or see, in sign languages). However, this does not require 'cutting' a morphophonological form into 'pieces'. For instance, when hearing a wordform like /sæŋ/, listeners have to infer that it is a past tense form of the syntactic root that gets spelled out as /sɪŋ/ in the present tense, but they don't need to segment it into constituent morphemes.[107] In other words, auditory comprehension consists of an inference problem where the aim is to get at the correct meanings by postulating the correct morphosyntactic structure from surface morphophonological forms.

The question then arises as to what lexical decision entails under this view. This process will look slightly different for the different theories we analysed in Chapter 2. Indeed, for theories like A-morphous morphonology, where the notion of word is still central, lexical decision entails determining that the wordform just heard corresponds to an existing lexical item combined with appropriate morphosyntactic features.

However, what does lexical decision entail in in theories like DM, Spanning and Non-isomorphomism where words do not play a special role in semantics or syntax, in that they are neither the locus of special meaning nor are the only objects manipulated by the syntax?[108] These theories are either compatible with or overtly contemplate the notion of phonological word, i.e., a morphophonological form that corresponds to a phonological domain, e.g., stress placement, vowel harmony, final devoicing (see Svenonius, 2016: 2).[109]

For the languages explored in this dissertation, we can use stress placement as the criterion to identify phonological words. In many cases, phonological words and orthographic words (i.e., string of

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[107] At least not in A-morphous morphology, Nanosyntax, Spanning, and Non-isomorphism. In DM, instead, where each morphosyntactic atom has to correspond to a morphophonological piece, reaching the correct morphosyntactic structure for /sæŋ/ would entail recognising that it actually consists of two morphophonological pieces, namely /sæŋ/ and the Ø spellout of the morphosyntactic feature past.
[108] It is unclear to me if wordhood plays a role in Nanosyntax.
[109] In Spanning, *w* isdentifies the stretch of morphosyntactic structure that gets realised by a single phonological word. Similar assumptions can be made for Non-isomorphism (Preminger p.c.). As far as I know, (mainstream) DM does not explicitly talk about phonological words, but it is definitely compatible with this notion.

letters that are separated by white spaces) coincide, though not always. For instance, conjugated verb forms in Italian and Hebrew are phonological words as well as orthographic words. Instead, articles aren't phonological words in either Italian or Hebrew since they can't stand in isolation and do not have their own stress, but they are orthographic words only in Italian, and not in Hebrew. This is just one example of how arbitrary the notion of orthographic word is.

While arbitrary, this notion is deeply entrenched in the literate cultures where it exists[110], and it is widely taught in schools. Thus, when participants are taking part in lexical decision tasks and they are asked whether what they heard is an existing word in their language, they are most probably responding using the notion of orthographic word. For the purposes of this dissertation, this doesn't matter since all the phonological words used here (nouns, verbs, adjectives and adverbs) are also orthographic words.[111] Thus, even if some theories do not ascribe a special status to words as syntactic and semantic objects, they still recognise their role as phonological objects, and thus, lexical decision can still be used as a meaningful task even if one adopts frameworks like DM, Spanning and Non-isomorphism.[112]

[110] Not all literature cultures have a notion of orthographic wors. For instance, Latin and Ancient Greek inscriptions, as well as the Chinese writing system, do not use white spaces in their orthographies.

[111] The situation would be different for sign languages, spoken-only languages and for languages whose writing system do not make use of blank spaces. First of all, it's unclear that these speakers and signers would necessarily have a notion of word in the first place. Even if they did (possibly borrowing it from another language they know whose writing system does use blank spaces), they might have disagreements on what constitute a 'word'.

[112] A bigger question is whether comprehension strictly needs to make use of phonological words. Indeed, a standard assumption in psycholinguistic theories of comprehension is that the first thing comprehenders do is identify word boundaries (even though it is unclear how they actually achieve this). However, if one abandons not only the traditional notion of morpheme, but also the traditional notion of wordhood, as theories like DM, Nanosyntax and Non-isomorphism ask us to do, comprehenders might or might not use phonological wordhood as a guiding principle in comprehension. Indeed, since a phonological word does not correspond to a syntactic or a semantic atom, it is unclear as to whether identifying phonological boundaries is strictly required for comprehension. Comprehenders could just continuously project morphosyntactic structure from the morphonological input they are receiving, without ever postulating boundaries (or, in DM, by only postulating boundaries of morphophonological objects that realise morphosyntactic atoms). Experiments on continuous speech/signs should be conducted to better understand how comprehension works if one doesn't a priori assume the centrality of words.

3.6 A note on modality

As we have seen in section 3.2, modality matters for priming effects. The great majority of priming experiments investigating 'morphological' relatedness either use masked visual priming or crossmodal auditory-visual priming. In a masked visual priming paradigm, participants are shown a forward mask, usually a series of hashtags (######), then the prime for a very short time (usually below 50ms) and finally the target, which is usually in a bigger font than the prime and also acts as a backward mask, as clear from Figure 3.3.[113] Since the prime is shown only for a very brief period of time and it is preceded and followed by a mask, participants are usually unaware of it. The fact that the prime is not overtly perceived is used to prevent strategic effects on the part of the participants.

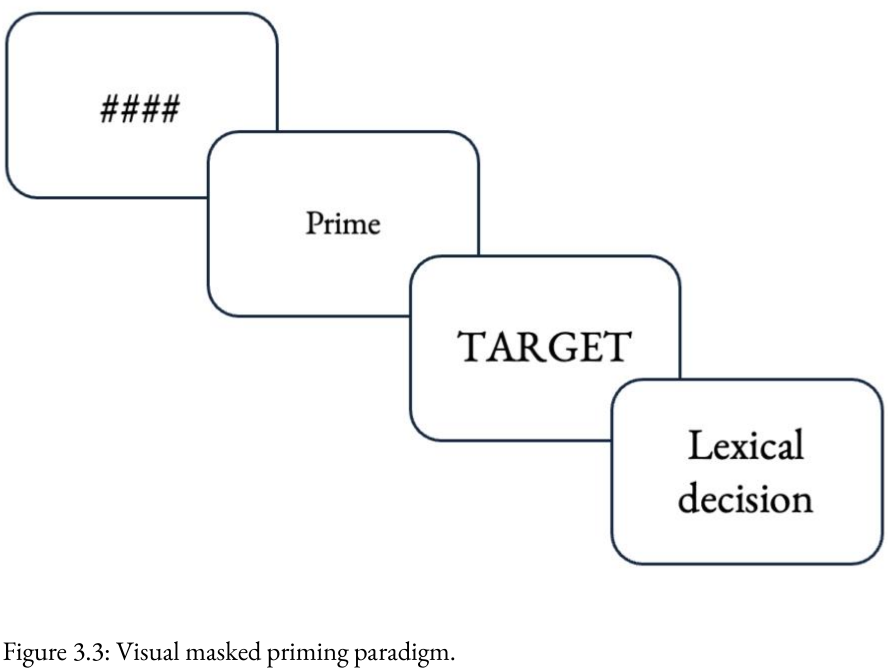


Figure 3.3: Visual masked priming paradigm.

[113] In experiments using the Latin alphabet, the prime is usually presented in lower case while the target in upper case.

Another widely used paradigm is cross-modal priming, which was primarily deployed by Marslen-Wilson's lab. In cross-modal priming, the prime is presented auditorily while the target is presented visually right after prime offset, as shown in Figure 3.4. While the prime is consciously perceived in this paradigm, the fact that prime and target are presented in different modalities is meant to ensure that the representation that priming is tapping into is an a-modal one, as opposed to a specifically auditory or visual one (see e.g., Marslen-Wilson et al., 1994).

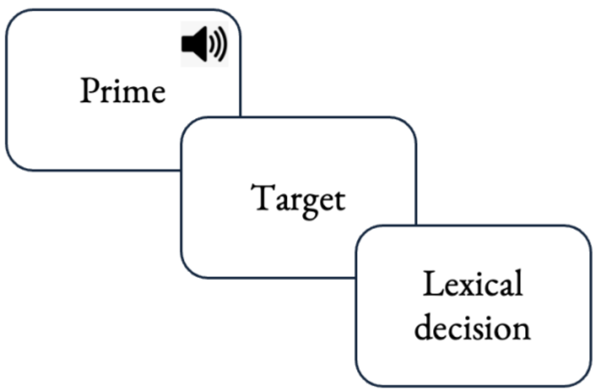


Figure 3.4: Cross-modal priming paradigm.

Even if these two priming paradigms have been greatly used in the field, they both share an important shortcoming. Indeed, by making use of visual primes and/or targets, they rely on orthographic representations. While orthographic representations are valuable to study in themselves, they only have an arbitrary relationship with phonological ones, as we have seen in the previous section. Moreover, differently from oral language, they are acquired later in life and only through overt instruction.

Thus, in order to avoid (as much as possible) influence from orthography, in this dissertation I will adopt an auditory-auditory priming paradigm. Using a fully auditory paradigm also allows us to build experiments that more closely mirror natural speech processing. Indeed, auditory and visual stimuli differ radically in their temporal properties. Auditory stimuli unfold over time such that any linguistic representation inferred from the auditory signal is also built over time. On the other hand, stimuli presented visually can be processed holistically and almost immediately, with both ends of the orthographic word available for processing at the same time. Moreover, co-articulation cues are available for listeners in the auditory modality, but not for readers in the written modality.[114] Thus, using auditory stimuli allows us to more closely mirror linguistic processing during speech and to tap more directly into phonological representations. While the use of auditory-auditory priming is not as widespread as visual priming, it is increasingly attested in the literature (Boudelaa and Marslen-Wilson, 2013; Creemers et al., 2020; Goodwin Davies and Embick, 2019; Schluter, 2013; Ussishkin, 2015; White et al., 2024).

Since in overt auditory-auditory priming participants are fully aware of primes, some measures are adopted here to prevent strategic effects. First, a lexical decision response is required after each stimulus, so that participants are unaware of the prime/target structure of the experiment, as shown in Figure 3.5. This is a continuous lexical decision task (as opposed to a paired one, see section 3.2). Moreover, the number of related prime-target pairs is kept to a minimum and always below 15% of the total items.[115]

[114] At least not in printed materials which are used in experiments.
[115] ISI stands for inter-stimulus interval.

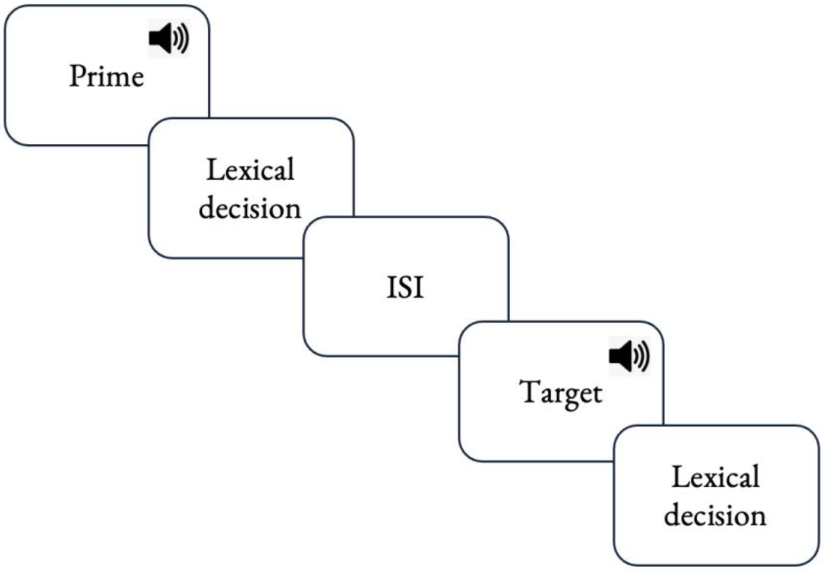


Figure 3.5: Auditory-auditory, continuous lexical decision priming paradigm.

3.7 Conclusions

'Morphological' effects of priming are widely attested in the literature. However, if we abandon the traditional notion of morphemes, we have to re-evaluate 'morphological' priming experiments in a new light. In this chapter we have seen that the cause of 'morphological' priming effects could be sharing a morphosyntactic representation, its specific meaning or its specific morphophonological realisation. While some work has been done to rule out a purely semantic origin of the priming, much more needs to be done to determine whether the origin of the priming is to be attributed to a morphosyntactic representation or to its morphophonological realisation. In the course of this dissertation, I will try to get at this question by using morphosyntax/morphophonology mismatches in two languages, namely Italian and Hebrew.

Rejecting the traditional notion of morpheme also challenges us to think differently of how comprehension and lexical decision work, requiring us to move away from a 'morpheme spotting' view of processing. Finally, in the experiments presented in this dissertation, an overt auditory-auditory, continuous lexical decision task is used to tap more directly into phonological representation and mirror as closely as possible natural speech processing.

Chapter 4

Priming of suppletive allomorphs

4.1 Background

The aim of this dissertation is to determine whether effects of 'morphological' priming are due to sharing morphosyntactic features or sharing the morphophonological realisation of those features. One of most promising avenues to address this question is to test whether suppletive allomorphs prime each other. Suppletive allomorphs are different morphophonological realisations of the same morphosyntactic features. For instance, in English, the morphosyntactic feature *plural* in English can be realised phonologically in various ways: /-z/ in regular plurals, /-ən/ as in *oxen*, /-ə/ as in *bacteria* or ∅ in *fish*. It is often the case that affix allomorphy is influenced by the identity of the root those affixes attach to. In these cases, usually one allomorph is the default realisation of a bundle of syntactic features, while the other allomorphs spelling out the same syntactic features are used only with specific roots. That's exactly the case of the realisation of English *plural*, where the /-z/ allomorph is used as default, and /-ən/, /-ə/ and ∅ are used only with specific roots. From an experimental point of view, these cases are not ideal since the differences in frequency and markedness among the various allomorphs might influence the experimental results in ways that cannot easily be controlled for. However, as we will see in the next section, Hebrew shows a kind of allomorphy in which the morphophonological realisation of the allomorphs changes as a function of the syntactic identity of another functional head, and not of the identity of the root. Thus, this constitutes a fully systematic case of allomorphy in which both allomorphs are equally frequent, providing an ideal case for experimental testing.

4.2 Hebrew morphology

Similarly to other Semitic languages, Hebrew has mainly a non-concatenative morphology, meaning that root consonants are interleaved with templates to create surface wordforms. For instance, when the root *k-t-b*, which is related to the meaning of writing, is interspersed with the XaYaZ[116] template[117], we obtain the word *katav* 'he wrote' (with spirantization of the final consonant) (see Cuonzo, 2023 for an overview of current analytical approaches to Semitic morphology). Even though Hebrew morphology is mainly non-concatenative, person and agreement affixes in verbs are always realised concatenatively (see Harbour 2023, Hewett 2023a,b, Kastner 2023, Shlonsky 2023). More

[116] XaYaZ is what is described as *pa'al* in traditional grammars. Here I adopt the convention, found also in Kastner (2019, 2020), to name templates as XaYaZ, where X stands for the first consonant of the root, Y for the second and Z for the third. This convention makes the morphophonological shape of the surface wordform clear, but also emphasises the fact that the 3 consonants of the root are different from one another (differently from other conventions, e.g. CaCaC).

[117] 'Template' here is used in a purely descriptive sense since all analyses of Semitic morphology since McCarthy (1979) do not regard templates as underived units (see Cuonzo, 2023).

specifically, person and number agreement features are always realised as suffixes in the past tense of the XaYaZ template, while they can be realised as both prefixes and suffixes in the future tense, as shown in Table 4.1.

Past tense			Future tense		
Person	**Verb form**	**Translation**	**Person**	**Verb form**	**Translation**
1sg	katav-ti	'I wrote'	1sg	e-xtov/ j-ixtov[118]	'I will write'
2sg masc	katav-ta	'you.sg.masc wrote'	2sg masc	t-ixtov	'you.sg.masc will write'
2sg fem	katav-t	'you.sg.fem wrote'	2sg fem	t-ixtev-ì	'you.sg.fem will write'
3sg masc	katav	'he wrote'	3sg masc	j-ixtov	'he will write'
3sg fem	katv-à	'she wrote'	3sg fem	t-ixtov	'she will write'
1pl	**katav-nu**	'we wrote'	1pl	**n-ixtov**	'we will write'
2pl masc	katav-tem	'you.pl.masc wrote'	2pl	t-ixtev-ù	'you.pl will write'
2pl fem	katav-ten	'you.pl.fem wrote'			
3pl	katv-ù	'they wrote'	3pl	j-ixtev-ù	'they will write'

Table 4.1: Person and number agreement affixes in the XaYaZ template.

For instance, in the past tense, the morphosyntactic bundle of features first person plural is realised as *-nu* in the past tense (see *katav-nu* bolded in the table above), while it is realised as the prefix

[118] In these forms, k spirantises to χ. Following conventions in Kastner (2020), for Hebrew transcriptions, I use IPA symbols with some modifications: 'x' stands for /χ/ and 'ji' for /i:/.

n- in future tense (as clear from the form *n-ixtov* bolded in the table above).[119] In other words, the same bundle of syntactic features, namely first person plural, is realised by two different phonological pieces, *nu-* and *n-* respectively. Importantly, the location of the affixes changes between the two allomorphs, such that past tense agreement markers are always prefixes, while future tense agreement markers are either suffixes or a conjunction of prefixes and suffixes. There is debate in the literature on what formal mechanisms should be used to achieve the correct ordering of person and agreement affixes in the different tenses and person/number combinations, but all the approaches agree in analysing these facts as a case of suppletive allomorphy. Moreover, since the choice of allomorph is due to the features of Tense, i.e. whether the verb is past or future, it is fully systematic and neither allomorph is more frequent than the other (differently from English *plural* which is realised as /-z/ in the vast majority of cases), making Hebrew person/agreement affixes an ideal case to test priming of suppletive allomorphs.

4.3 Previous studies

While the number of studies on morphological priming is substantial, only a handful of studies have investigated affix priming. The majority of affix priming studies have looked at derivational affixes and not at inflectional affixes, which we focus on here. As noted by Goodwin Davies and Embick (2019), this might be an instance of the 'file-drawer problem' (Rosenthal 1979), where previous experiments on

[119] Kastner (2020: 47) gives the *i* in *nixtov* as part of the person affix, and not as a tense affix as I do in Table 4.1. However, treating it as a tense affix accounts for the fact that *i* is found in all future XaYaZ forms, irrespective of person. This is what Kastner (2020: 86) calls 'choice points': the exact segmentation of affixes does not have analytical consequences as far as all the segments spell out some syntactic structure. This choice doesn't have any consequences for the experiment either since the amount of phonological overlap between the past tense suffix and the future tense prefix is still just one phoneme, namely *n*.

inflectional affix priming might have not been published because they yielded null results. Of the published studies, some studies do find affix priming (e.g. Duñabeitia et al., 2008), but others don't (e.g. Giraudo and Grainger, 2003). Cho et al. (2024) performed a meta-analysis of all the affix priming experiments carried out in the visual modality arriving at the conclusion that suffix priming effects might be very small (between 10 and 15ms) and therefore might require at least 100 participants to be detectable. They conclude that many of the studies found in the literature might be underpowered and that is why affix priming might be difficult to identify. Since the state of the art on affix priming has been reviewed in Cho et al. (2024) and Goodwin Davies and Embick (2019), here I report only on a handful of studies which are most relevant.

Smolík (2010) is probably the study that is closest in spirit to the experiments carried out in this chapter since it tests priming of inflectional allomorphs. Indeed, in Czech, the feminine nominative can be spelled out as *-e* or as *-a*. Moreover, the masculine genitive/accusative can sometimes be spelled out as *-a*. Smolík (2010) used a feminine nominative target (*váha*) and compared priming from a feminine nominative prime ending in *-a* (*lípa*), a feminine nominative prime ending in *-e* (*vůle*) or a masculine genitive/accusative ending in *-a* (*syna*). The unrelated condition was a string of XXXX. The prime was either shown for 50 or 150ms. In the former case, there was a small priming effect (10ms, $p < 0.05$) in the condition where the prime was a feminine nominative noun ending in *-a* and a bigger effect (17ms, $p < 0.01$) in the condition where the prime was a feminine nominative noun ending in *-e.* At 150ms instead, both these conditions elicited a limited priming effect (respectively 13 and 12ms at $p < 0.05$), while there was a much bigger effect (20ms, $p < 0.001$) in the condition where the prime a masculine genitive/accusative noun ending in *-a*. These results cautiously show some evidence for priming across allomorphs, but given the complicated pattern in the data more evidence is needed to adjudicate these facts.

Emmorey (1989) investigated auditory priming of affixes in English. Experiment 2 compared priming of inflectional affixes (*smiling* → *breaking*), derivational affixes (*shortness*→ *blackness*) and shared phonological material (*tango* → *cargo*) to unrelated controls. Statistically significant priming was found in the derivational and shared phonological condition, but not in the inflectional condition. Since in the former two conditions prime and target shared the final syllable, Emmorey (1989) tested in Experiment 3 a new set of conditions, prime and target sharing an inflectional affixes but not the whole final syllable (*smiling* → *breaking*), prime and target sharing an inflectional affixes and the whole final syllable (*dumping* → *shaping*) and the same phonological control as in the previous experiment (*tango* → *cargo*). A significant priming effect was found in the latter two conditions, but not in the former one, showing that the priming effect was really due to phonological similarity (i.e., sharing the last syllable) more than anything else.

In a cross modal priming experiment, Reid and Marslen-Wilson (2000, Ex 1) reported priming for various derivational and inflectional affixes when treated as a single condition. Moreover, in Experiment 2 they found priming for secondary imperfective affixes in Polish, across 12 interveners (*roz-pakow-ywa-l-em* 'to unwrap, 1st person sing., masculine, past tense, secondary imperf.' → *roz-walkow-ywa-c* 'to flatten something using a rolling-pin, secondary imperf.'). More recently, Goodwin Davies and Embick (2019) found auditory priming for the English plural affix /-z/ (*crimes* → *trees*) over both a phonological control (*cleanse* → *trees*) and a singular control prime (*crime* → *trees*). In line with what argued in Cho et al (2024), the amount of priming found by Goodwin Davies and Embick (2019) is small (RTs to plural primes was 29ms faster than in the phonological control condition) and was observed only with a high number of participants (228, of which 28 were excluded from the analysis for low accuracy). In a similar line of work, White et al. (2024) investigated auditory priming for the *-ing* suffix in English across two possible phonological realisations, namely *-ing* and *-in'*. Over various experiments, they found priming effects independently of how the suffix was realised phonologically. White et al. (2024) constitutes the closest antecedent to the experiments in this chapter since they demonstrate affix priming across different phonological realisations. However, there is debate in the analytic literature on whether *-ing* and *-in'* are suppletive allomorphs of each other or whether *-in'* is derived from *-ing* phonologically (see White et al., 2024: 1-4 for a brief overview of the analytical literature). Therefore, the experiments reported in this chapter constitute a further development of the line of experimentations carried out in White et al. (2024) in that they test the priming of suppletive allomorphs which, moreover, share only one segment and are located in different positions in the word.

4.4 Experiment 4.1

The characteristics of Hebrew person/number agreement affixes make them the ideal test case to disentangle experimentally morphosyntactic features from their morphophonological realisations. Indeed, as illustrated in section 4.2, person/number agreement affixes in Hebrew are realised differently depending on tense, making this a case of systematic allomorphy. Among the possible person affixes, we chose the first person plural affixes, respectively *-nu* for the past tense and *n-* for the future tense. These affixes were chosen for 2 reasons: first of all, they are not homophonous with other forms in the paradigm, and, secondly, the bundle of syntactic features is the same in the past tense and future tense (as opposed to other cases where that's not the case: for instance, the distinction between masculine and feminine, which is present in the past tense 2nd plural form, is lost in the future tense). The affixes *-nu* and *n-* share only one segment with each other, and they are found in different positions in the wordform (*-nu* is a suffix and *n-* a prefix), reducing even further the phonological similarity between past and future first person forms. In the first experiment, we compared two morphosyntactic conditions with an unrelated nominal control.

4.4.1 Methods

4.4.1.1 Materials

The critical stimuli that formed the targets in this experiment are 36 first person plural XaYaZ verbs in the future tense, such as *nirkoʃ* 'we will buy'. Targets were all 2 syllables long. Mean target duration was 809ms. Each target was combined with 3 different primes to create 3 experimental conditions, resulting in 108 prime-target pairs. These were distributed across 3 experimental lists in a Latin Square design, such that each list contained 36 prime-target pairs (12 from each of the 3 conditions) and no target was repeated in any given list.

In the first condition (+Pers +Num), primes were 12 first person plural verbs in the past tense, such as *balatnu* 'we stood out' (root *b-l-t*). In this condition primes and targets were in the same person and number, but in different tenses. 7 of the primes in this condition were XaYaZ verbs and 5 were XiYeZ verbs, and all of them were 3 syllables long.[120]

In the second condition (-Pers +Num), primes were 12 third person plural verbs in the past tense whose last root consonant was *n*, such as *natnu* 'they marked' (root *n-t-n*). In this condition primes and targets were both plural, but were in different tenses and different persons. 7 of these were XaYaZ verbs and 5 were XiYeZ verbs, and all of them were 2 syllables long. Verbs whose last root consonant is *n* were chosen to provide as close a phonological match as possible to the first condition. Indeed, primes in both the first and second condition end in *-nu*, however the segmentation is different in the 2 conditions: in the first condition *-nu* is the spell-out of the 1st plural agreement marker (*balat-nu*), while in the second condition *-n* is part of the root and *-ù* is the spell-out of the 1st plural agreement marker (*natn-u*). It is worth noting that the stress pattern is different in two conditions: the stress falls on the penultimate syllable for primes in the first condition (*ba'latnu*), while it falls on the last one for primes in the second condition (*nat'nu*).

Finally, primes in the unrelated condition consisted of morphologically complex nouns that were 3 syllables long. Prime target pairs in all conditions were created such that prime and target shared at most 1 consonant (excluding *n* in Condition 1 and 2). Conditions are summarised in Table 4.2. The full list of critical items can be found in Appendix A.

[120] Both XaYaZ and XiYeZ verbs were used in order to match as closely as possible items in the -Pers +Num and in the -Pers +Num conditions. Indeed, there weren't enough roots occurring in the XaYaZ template whose last consonant was *-n* and thus roots occurring in the XiYeZ template had to be used as well.

Condition	Prime	Target
1. +Pers +Num	*balatnu* ‘we stood out’	
2. -Pers +Num	*natnu* ‘they gave’	*nirkoʃ* ‘we will buy’
3. Unrelated	*healmut* ‘disappearance’	

Table 4.2: Experiment 4.1: design and sample stimuli.

To prevent strategic effects, 264 filler pairs were included, so that critical prime-target pairs made up only 12% of all items. The total number of items thus amounted to 600 items, 50% of which were real words and 50% non-words. Fillers were divided between nouns (175 out of the 300 real words) and future and past tense verbs (59 out of 300 real words) in the XaYaZ, XiYeZ and hiXYiZ templates conjugated in a variety of persons but never in 1st person plural form to avoid overlap with targets. Fillers were either 1, 2 or 3 syllables long. Each root occurred only once in the whole experiment.

Non-words were created by a native speaker of Hebrew by conjoining non-existing roots with existing nominal and verbal templates (for the verbal templates only XaYaZ, XiYeZ and hiXYiZ were used to match the real words of the experiment). The non-existing roots were created by selecting real roots and changing the second or third root consonant so that participants had to listen to a relevant portion of each audiofile before being able to make a lexical decision. Nonwords were created in such a way that they shared at maximum 2 root consonants with primes and targets. Nonwords too were either 1, 2 or 3 syllables long. Stimuli were recorded by an adult female native speaker of Hebrew with a microphone Mono Set CMC 6 in a sound attenuated booth. Each item was recorded 3 times and the best sounding audio was then chosen to be used in the experiment. Audiofiles were segmented using Praat (Boersma and Weenink 2015) and normalised to a peak amplitude of 70 dB SPL.

4.4.1.2 Participants

40 participants that self-identified as native speakers of Hebrew were recruited online using the Prolific platform. We had originally planned to collect data from more participants, but given the unexpected rejection of a high percentage of primes in the -Pers +Num condition (see below), we decided to stop at 40. Participants were paid 7.50$ for their participation in the experiment, which lasted approximately 30 minutes.

4.4.1.3 Procedure

The experiment was conducted online using the Penn Controller for Internet Based Experiments (PCIbex) (Zehr and Schwarz, 2018). All stimuli were presented auditorily. A continuous lexical decision task was used, so a response was provided to both primes and targets, as clear from Figure 4.1. The distinction between primes and targets was not made explicit to participants.

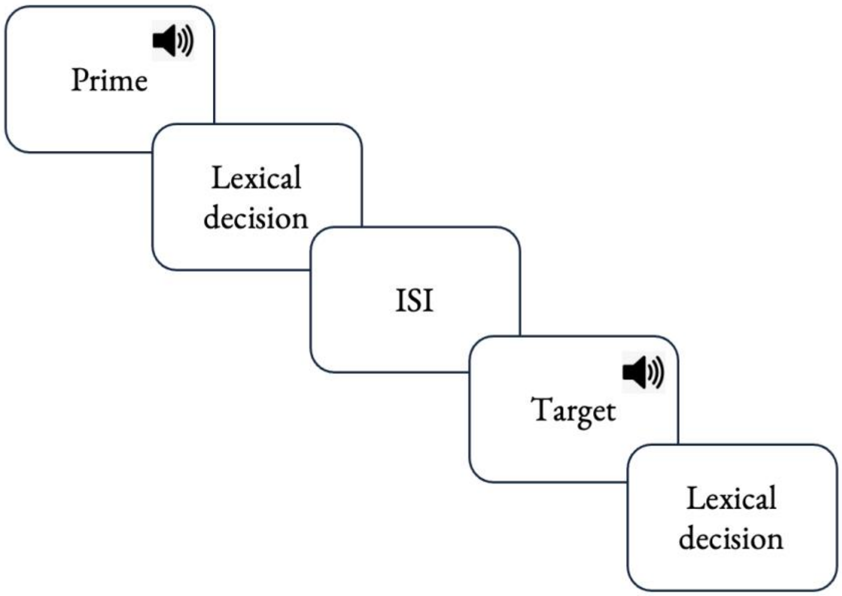


Figure 4.1: Continuous auditory lexical decision.

The task had a random inter-stimulus interval between 400-600ms to prevent participants from responding rhythmically. The ISI was measured from the end of the sound file or participant response, whichever was later. Stimuli presentation was pseudo-randomised throughout the experiment for each participant such that critical prime target pairs occurred at the maximum possible distance from each other. The experiment consisted of 3 blocks with the possibility for a self-administered break after each block, preceded by a practice period of 28 items (50% nonwords) at the beginning of the experiment in which participants were familiarised with the task and were provided feedback on each response.

At the beginning of the experiment, participants were instructed that they would hear existing and non-existing Hebrew words, and that they had to make a lexical decision to each word as fast and as accurately as possible. Responses of ‘word’ and ‘non-word’ were recorded from keyboard (F and J) button presses. Participants were instructed to use headphones during the experiment.

4.4.2 Analysis

4.4.2.1 Data trimming

Trials with incorrect responses to primes or targets were discarded, which led to an exclusion of 271 data points out of a total of 1440 trials (36 targets * 40 participants). All targets with outlier RTs (<250ms and >2000ms) were excluded, as well as the targets for which the prime had an outlier RT (<250ms and >2500ms). This led to a further exclusion of 35 data points. In total, the data trimming process led to the exclusion of 306 observations, or 21.25% of the data. The great majority of exclusions occurred because of primes in the -Pers +Num condition, which were 3rd person plural verbs whose third root consonant was *-n*.

4.4.3 Results

An overview of the results is provided in Table 4.3 and in Figure 4.2. Table 4.3 gives the raw RT data, while Figure 4.2 is based on the log-transformed RT data. The conditions did not differ much from each other, and the +Pers +Num condition and the -Pers +Num condition were actually slightly (respectively, 4ms and 7ms) slower than the Unrelated condition, going against our predictions. Table 4.4 shows accuracy rates, highlighting how a very high percentage of primes in the -Pers +Num were rejected. Target accuracy rates by prime condition show much higher accuracies in the +Pers +Num and the -Pers +Num conditions compared to the Unrelated, as expected. Given the high percentage of rejections in the -Pers +Num conditions, we decided to not collect the full sample of participants for this experiment and to not run any statistical tests.

Condition	Target RT	Priming effect
1. +Pers +Num (*balatnu - nirkoʃ*)	1147 ms (208)	+4ms
2. -Pers +Num (*natnu - nirkoʃ*)	1150 ms (230)	+7ms
3. Unrelated (*healmut - nirkoʃ*)	1143 ms (217)	N/A

Table 4.3: Mean response times to the targets (in ms), priming effects (in ms). RTs are measured from the onset of the sound file. Priming effect is the RT for each condition minus the RT in the unrelated condition. Standard deviations are given in parentheses.

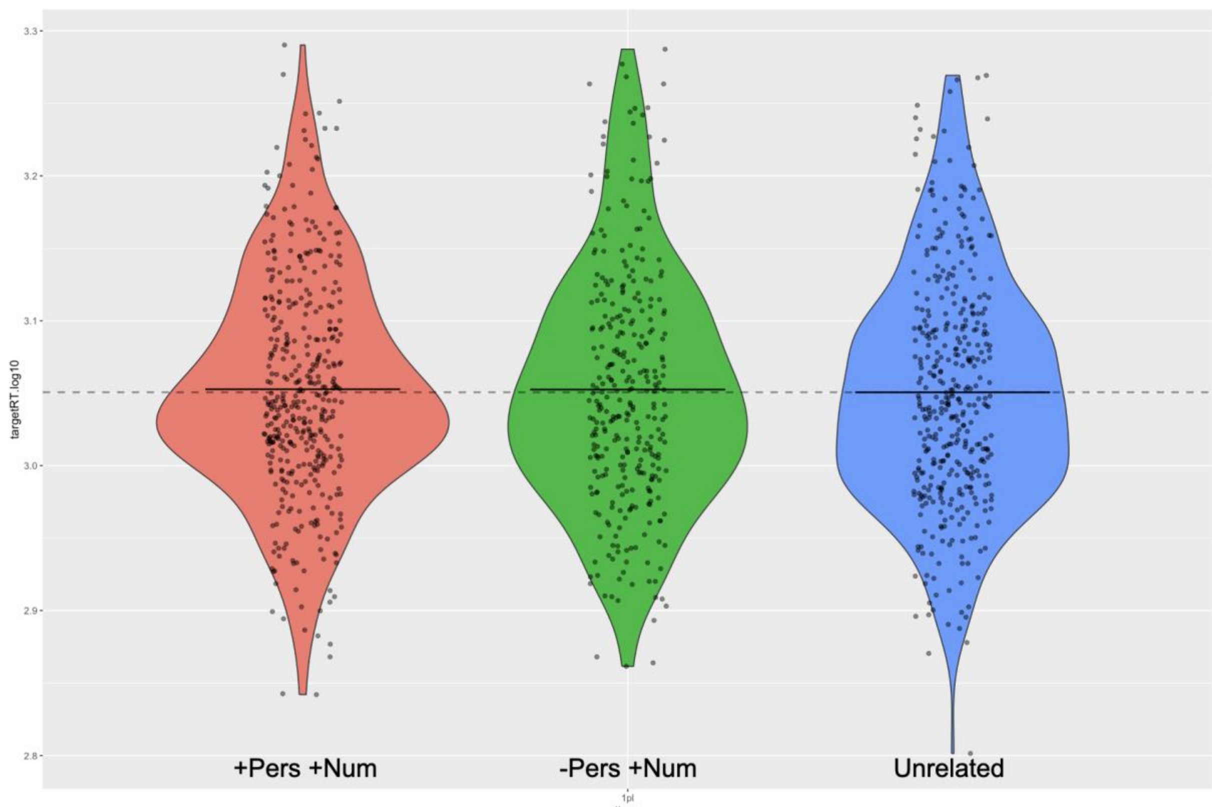


Figure 4.2: Violin plots of the log-transformed response times in Experiment 4.1 for the +Pers +Num, -Pers +Num and the unrelated condition. Black horizontal lines represent means by condition, dotted grey line represents the mean in the Unrelated condition.

	% accuracy

Condition	Primes	Targets
1. +Pers +Num (*balatnu - nirkoʃ*	93.5%	93.8%
2. -Pers +Num (*natnu - nirkoʃ*)	73.5%	93.1%
3. Unrelated (*healmut - nirkoʃ*	97.5%	87.3%

Table 4.4: Error rates (number of incorrect responses) to targets and primes per condition.

4.4.4 Discussion

The goal of this experiment was to investigate cross-allomorph affix priming. The results show no evidence of facilitation. However, some issues in the experimental design might have affected the results. First of all, there were differences in the RT to our primes, and recent work has argued that RTs to the prime have a direct impact on RTs to the target in auditory lexical decision (Creemers et al., 2020, Goodwin Davies and Embick, 2019, White et al., 2024). As shown in Table 4.5, RTs to primes in the Unrelated condition were much faster than in the other two conditions. This might be due to various reasons. As we have seen above, primes in the -Pers +Num condition were rejected as non-words at high rates and the especially slow RTs to primes in this condition could have been due to the same reason. Secondly, primes in the Unrelated condition, which were all nouns, were much more frequent than primes in the other two conditions (see again Table 4.5). Frequencies were extracted from the SketchEngine's HebTenTen corpus, which contains more than 2.7 billion words from internet texts. Furthermore, analysis of filler items revealed that RTs to nouns were always faster than to verbs.

Prime type	Prime RT	Prime frequency	Prime Duration
1. 1st plur past tense (*balatnu*)	1147 ms (208)	5309	744ms
2. 1st plur future tense (*natnu*)	1202 ms (230)	12587	584ms
3. Noun (*healmut*)	1027ms (217)	118674	764ms

Table 4.5: Mean response times to prime (in ms), mean prime frequencies and mean prime duration.

Another difference was that primes in the -Pers +Num condition were always 2 syllables long, while primes in the other two conditions were always 3 syllables long (see mean wav file durations reported in Table 4.5). Although the -Pers+Num condition had slower prime RTs than the other two conditions, we could imagine that they might have been even slower if not for its briefer duration. All of these facts might have had an effect on Prime RT. However, if prime RT indeed directly impacts target RT as 'spillover effects', then for any experimental design which does not achieve matched prime RTs across conditions in this experiment, the interpretation of RTs at the target would now come into question. The current experiment would clearly be subject to this concern since we observed clear differences in prime RTs across conditions.

Secondly, the fact that primes in the -Pers +Num were refused as nonwords in 26.5% of the cases was completely unexpected. Two native speakers (Si Berrebi p.c. and Itamar Kastner p.c.) were consulted to determine what could have led to such high rejection rates. Both pointed out that the items were acceptable, albeit rare. Berrebi (p.c.) remarked that there is a possible phonological alternation with some of the words containing *x*: for instance, *bax'nu* and *tax'nu* could also be pronounced as *baxa'nu* and *taxa'nu*). However, not all of them show this alternation (e.g. *ʃax'nu* but **ʃaxanu*), and thus this can't be the only reason for rejection. Kastner (p.c.) also noticed that differently from verbs in the 1st person plural form, verbs in the 3rd person plural form do not allow subject drop. However, rejection rates for 3rd person plural verbs among filler items was much lower. Thus, none of these factors (frequency, variation in pronunciation, prodrop restrictions) seem to independently explain the high rejection rates in the -Pers +Num condition. Either a combination of these factors or some other factor might have contributed to the rejection pattern we see.

In sum, this experiment did not show any priming effect, but various issues with the design might have influenced the results. In order to more accurately investigate cross-allomorph affix priming, we ran a follow-up experiment including a conjugated verb as an unrelated control and eliminating the -Pers +Num condition given its high rejection rates.

4.5 Experiment 4.2

In our second experiment, we changed the design to better address the question of whether there can be cross allomorph affix priming. First of all, we decided to have a 2nd person singular masculine verb as the Unrelated control, to have as matched a control as possible. Moreover, the -Pers +Num condition was eliminated since a high percentage of primes in this condition were refused as nonwords. The resulting experiment had only 2 conditions and was thus shorter.

4.5.1 Methods

4.5.1.1 Materials

The materials for experiment 4.2 were a selected subset of the materials recorded for Experiment 4.1. The critical stimuli that form the targets in this experiment are 24 first person plural XaYaZ verbs in the future tense, such as *nirkoʃ* 'we will buy'. Since the most frequent items in Experiment 4.1 usually also had the highest accuracy rate, the 24 most frequently used targets of Experiment 4.1 were chosen as targets of Experiment 2. However, 3 of these targets (*nixlol*, *nimzog* and *nixpol*) had a 82,6% accuracy rate in Experiment 1, thus they were substituted with 2 targets that were less frequent but that had higher accuracy rates (*nivgod*, *nitzrov* and *nifloʃ*). Targets were all 2 syllables long. Mean target duration was 803 ms and was included in the model as a predictor of target RT (see section 4.5.2.2). Each target was combined with 2 different primes to create 2 experimental conditions, resulting in 72 prime-target pairs. These were distributed across 2 experimental lists in a Latin Square design, such that each list contained 24 prime-target pairs (12 from each of the 2 conditions) and no target was repeated in a given list.

In the first condition, primes were 12 first person plural XaYaZ verbs in the past tense, such as *balatnu* 'we stood out'.[121] In this condition primes and targets shared were in the person and number, but in different tenses. In the second and last condition, primes were 12 second singular masculine XaYaZ verbs in the past tense, such as *galaʃta* 'you.sing.masc surfed'.[122] This condition was chosen as the unrelated control since primes and targets in this condition did not share any person or number

[121] Since the -Pers +Num condition was absent in this experiment, there was no need to have XiYeZ in the +Pers +Num condition and all the primes in this condition were XaYaZ verbs. 7 were the same as Experiment 4.1 and 5 were verbs that were originally recorded for Experiment 4.1, but that ended up not being used in that experiment.

[122] Similarly, these primes were originally recorded for Experiment 1.1, but were not used in that experiment.

features.[123] Prime target pairs in all conditions were created such that prime and target shared at most 1 consonant (excluding *n* in Condition 1). Conditions are summarised in Table 4.3. The full list of critical items can be found in Appendix B.

Condition	**Prime**	**Target**
1. +Pers +Num	*balatnu* 'we stood out'	*nirkoʃ* 'we will buy'
2. Unrelated	*galaʃta* 'you.sing.masc surfed'	

Figure 4.3: Experiment 4.2: design and sample stimuli.

To prevent strategic effects, 216 filler pairs were included, so that critical prime-target pairs made up only 10% of all items. The total number of items thus amounted to 480 items, 50% of which were real words and 50% non-words. Fillers were divided between nouns (140 out of the 240 real words) and future and past tense verbs (52 out of 240 real words) in the XaYaZ, XiYeZ and hiXYiZ templates conjugated in a variety of persons but never in 1st plural form or the 2nd singular masculine form to avoid overlap with targets and primes. Fillers were either 1, 2 or 3 syllables long. Each root occurred only once in the whole experiment. The nonwords were a subset of those used in Experiment 4.1, divided between 100 pseudoverbs and 140 pseudonouns to match the real words (see section 4.3.1.1 for more details on nonword characteristics). Since the materials for this experiment were a selected subset of the

[123] If one adopts a feature based view of person à la Harbour (2016), then 1pl and 2sg share a feature in common: namely, +participant. However, they are different enough in other ways (+ vs -author, + vs -pl) to be a good control for this experiment.

materials recorded for experiment 4.1, the recording parameters were the same as those (see section 4.3.1.1).

4.5.1.2 Participants

78 participants (38 in List 1 and 40 in List 2) that self-identified as native speakers of Hebrew were recruited online using the Prolific platform. We originally planned to collect data from 120 participants but, since the number of native speakers of Hebrew on Prolific is limited, we were unable to collect the full sample. Participants were paid 5.00$ for their participation in the experiment, which lasted approximately 20 minutes.

4.5.1.3 Procedure

Procedure was the same as Experiment 4.1. The only difference is that there were 26 items in the practice, instead of 28.

4.5.2 Analysis

4.5.2.1 Data trimming

Mean accuracy by subject (as calculated on both critical and filler items) was extremely high (94.3%) and the participant with the lowest accuracy had an accuracy of 76.7%, so no participant was excluded on the basis of low accuracy. Trials with incorrect responses to primes or targets were discarded, which led to an exclusion of 127 data points out of a total of 1872 trials (24 targets * 78 participants). All targets with outlier RTs (<250ms and >2000ms) were excluded, as well as the targets for which the prime had an outlier RT (<250ms and >2500ms). This led to a further exclusion of 67 data points. In total, the data trimming process led to the exclusion of 194 observations, or 10.36% of the data.

4.5.2.2 Modelling

The data were analysed as follows. Responses were coded for response type (word/non-word) and response time (RT; measured in ms from the onset of the sound file). RT data were then log-transformed (base 10). We analysed effects on log-transformed RT (our dependent variable) with linear mixed-effects models, using the lme4 package (Bates et al. 2015, version 1.1-37) in the R environment (R Core Team 2024, version 4.5.0). We first fit a model that included a random slope for subject and a random intercept for target items. Since this model was singular, we fit a new model including random intercepts for subjects and target items. The following fixed effects are included in the model: Condition (+Pers +Num, Unrelated), Trial Number, Target Frequency, Target Duration and Prime RT. Trial Number and Target Frequency were chosen because they are generally known to influence Target RT. Target duration was inserted given the auditory nature of the experiment. Similarly, Prime RT was included because it was shown to have a direct impact on target RTs in similar experiments (Creemers et al., 2020, Gaston et al., 2021; Goodwin Davies and Embick, 2019, Loui et al., 2021; White et al., 2024). Target frequencies were extracted from SketchEngine's HebTenTen corpus. Condition was treatment coded with the Unrelated condition as the reference level. Target Frequency, Target Duration and Prime

RT are log10 transformed and z-scored, while Trial Number was z-scored. P-values are determined using the package lmerTest (Kuznetsova et al. 2016); significant p-values are reported at $p < 0.05$.

4.5.3 Results

An overview of the results is provided in Table 4.8 and in Figure 4.3. Table 4.7 gives the raw RT data, but note that the analyses are done on the log-transformed RT data (as indicated in Figure 4.3). RTs to targets in the +Pers +Num condition were 23ms faster than in the Unrelated condition. The analysis of the log-transformed RT data revealed significant facilitation ($p<0.05$) in the +Pers compared to the Unrelated condition. Table 4.8 shows accuracy rates. Table 4.9 shows the model summary and reports the model formula (a best practice suggested by Meteyard and Davies [2020]).

Condition	RT target	Priming effect
1. +Pers +Num (*balatnu - nirkoʃ*)	1102 ms (208.4171)	-23ms
2. Unrelated (*galaʃta - nirkoʃ*)	1125 ms (217.0069)	N/A

Table 4.6: Mean response times to the targets (in ms), priming effects (in ms). RTs are measured from the onset of the sound file. Priming effect is the RT for each condition minus the RT in the unrelated condition. Standard deviations are given in parentheses.

	% accuracy	
Condition	**Primes**	**Targets**
1. +Pers +Num (*balatnu - nirkoʃ*)	95.1%	98.1%
2. Unrelated (*galaʃta - nirkoʃ*)	95.3%	97.3%

Table 4.7: Violin plots of the log-transformed response times in Experiment 5.1 for the Root and prefix; Root only and unrelated conditions. Black horizontal lines represent means by condition, dotted grey line represents the mean in the unrelated condition.

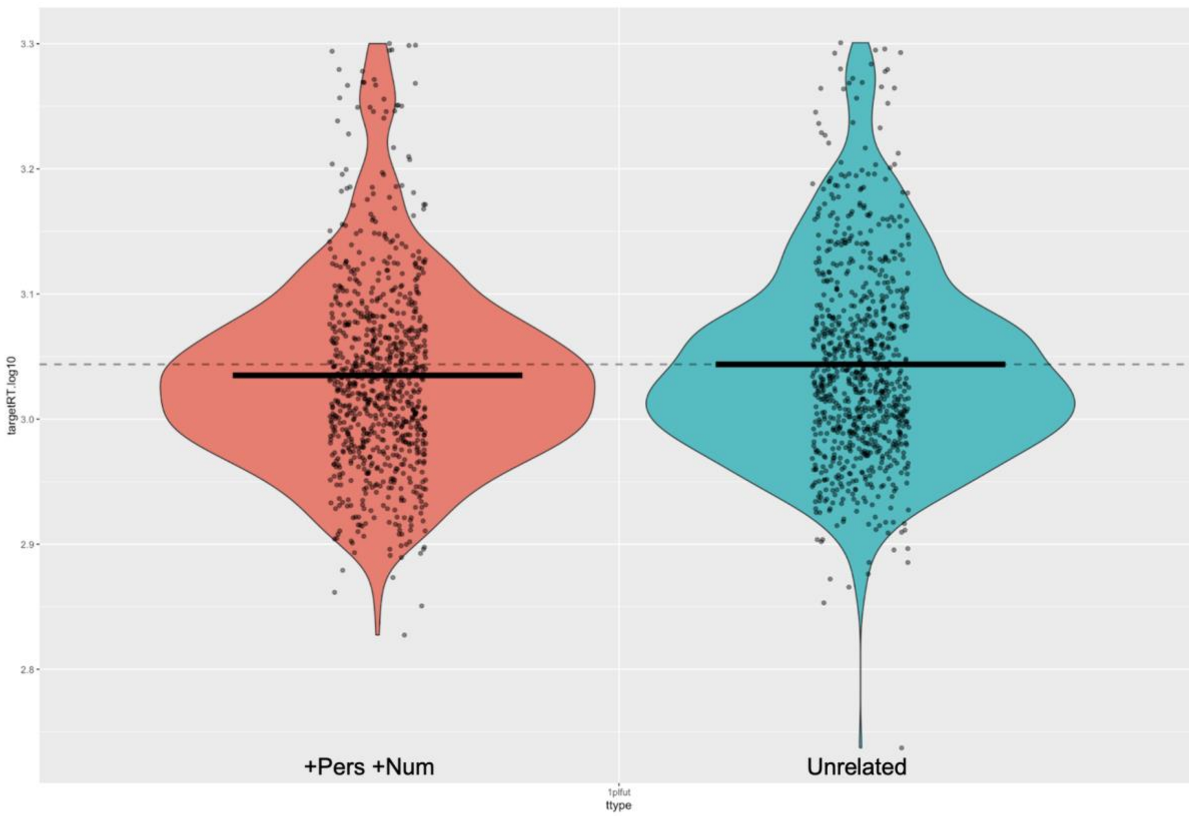


Figure 4.5: Violin plots of the log-transformed response times in Experiment 5.1 for the Root and prefix; Root only and unrelated conditions. Black horizontal lines represent means by condition, dotted grey line represents the mean in the unrelated condition.

	Log10 transformed RTs		
Fixed effects	*Estimate (β)*	*CI*	*p-values*
Intercept	3.044	3.034 – 3.055	**<.001**
Prime type +Pers+Num vs. Unrelated	-0.006	-0.011 – -3.9E-04	**0.036**
Trial Number	-0.005	-0.010 – -4.1E-04	**0.038**
Log10-transformed Target Frequency	-0.008	-0.013 – -0.002	**0.015**

Log10-transformed Target Duration	0.009	0.003 – 0.014	**0.005**
Log10-transformed Prime RT	0.02	0.016 – 0.024	**<.001**
Random effects	*N*	*Variance*	*SD*
Subject	78	0.002	0.041
Targets	24	1.3E-04	0.011
Residual		0.003	0.057
N Datapoints			1678

Table 4.8: Violin plots of the log-transformed response times in Experiment 5.1 for the Root and prefix; Root only and unrelated conditions. Black horizontal lines represent means by condition, dotted grey line represents the mean in the unrelated condition.

4.5.4 Discussion

In Experiment 4.2 we aimed at determining whether there can be priming of suppletive allomorphs in Hebrew. We tested this by having a condition in which prime and target are both first person plural verbs, but they are in different tenses, such that 1pl is spelled out as the suffix *-nu* in the prime and as the prefix *n-* in the target. The different location of these affixes and the fact that prime and target only had one segment in common greatly reduced the possibility of a phonological effect of priming. We compared this condition to an Unrelated condition where the prime was a second person masculine verb in the past tense. Even if the number of participants we managed to collect data from is smaller than what we initially intended, we found that responses to targets in the +Pers+Num condition were significantly faster ($p<0.05$) than in the Unrelated condition, providing initial evidence that priming is sensitive to morphosyntactic identity above and beyond morphophonological similarity.

4.6 General discussion

In this chapter, we investigated a case of suppletive allomorphy in the inflectional domain in Hebrew. We wanted to determine whether two different morphophonological realisations of the same bundle of morphosyntactic features can prime each other. We were interested in this because we wanted to determine whether priming experiments are more finely attuned to morphosyntactic features than to morphophonological realisations of those features.

In Experiment 4.1 we tested this by comparing three different priming conditions. In the +Pers +Num, primes and targets were 1st person plural verbs in different tenses. In the -Pers +Num, primes were 3rd person plural verbs in the past tense whose last root consonant was *n* and targets were 1st person plural verbs in the future tense. In both conditions, the amount of phonological overlap between primes and targets were the same but in the first condition primes and targets were more similar morphosyntactically. In the unrelated condition, the prime was a noun. For reasons that remain unclear, a high percentage of primes in the -Pers +Num were rejected as non-words by participants in the experiment. Moreover, response times to targets across the three different conditions were very similar to each other. A series of issues in the experimental design could have led to the lack of any priming effects.

Since Experiment 4.1 yielded inconclusive results, we ran a second experiment in which we eliminated the -Pers +Num condition (given high rejection rates among primes in this condition) and in which primes in the Unrelated condition were 2nd singular masculine verbs in the past tense. This was done to ensure that the Unrelated condition constituted as close of a control condition to the +Pers

+Num condition as possible. In this experiment, we found a significant priming effect in the +Pers +Num condition, where prime and targets were both 1st person plural verbs. These results are quite important because they show that priming can detect shared morphosyntactic features between primes and targets, even if these features are realised morphophonologically in different ways (respectively, the suffix *-nu* in primes and the prefix *n-* in targets). This is initial evidence that priming is sensitive to morphosyntactic features independently of morphophonological similarity.

The present results broaden our understanding of priming more in general for various reasons. First of all, in the visual modality, affix priming is not always reliably found (e.g. Duñabeitia et al., 2008 vs. Giraudo and Grainger, 2003). Indeed, Cho et al. (2024) recommend very big sample sizes to obtain affix priming. In the auditory modality, Goodwin Davies and Embick (2019) found auditory priming for the English plural affix /-z/ (*crimes* → *trees*) over both a phonological control (*cleanse* → *trees*) and a singular control prime (*crime* → *trees*). The results in Experiment 4.2 are in line with Goodwin Davies and Embick (2019) that priming is more finely attuned to morphosyntax than morphophonology. On the other hand, these results differ radically from the ones in Emmorey (1989) that found similar priming effects for words sharing suffixes (*shortness*→ *blackness*) and words that just had the last syllable in common (*tango* → *cargo*), thus pointing towards a phonological origin of the priming. There are important differences between the experiment 2 and 3 in Emmorey (1989) and the present one. First of all, Emmorey (1989) is a paired lexical decision task in which only targets are responded to. Secondly, the number of related items in those experiments corresponds to 25%, while it is a mere 10% here. Both these factors may have made participants especially attentive to phonological similarity, while the present set-up reduced as much as possible the chances of that happening.

The results in Experiment 4.2 are also novel in that they show priming of suppletive allomorphs. To the best of our knowledge, priming of suppletive allomorphs has been attempted only in the visual modality in Smolík (2010), with a complicated pattern of results (see section 4.3). In the auditory modality, White et al. (2024) showed priming between the allomorphs *-ing* and *-in'*, but there is debate in the analytical literature on whether these are suppletive allomorphs of each other or whether *-in'* is derived from *-ing* phonologically. Thus, this is the first time that priming of suppletive allomorphs has been shown experimentally, at least in the auditory modality. While further evidence for priming of inflectional suppletive allomorphs should be definitely collected, Experiment 4.2 provides initial but convincing evidence that priming can detect shared morphosyntactic structure above and beyond morphophonological similarity.

4.7 Conclusion

In this chapter we investigated whether we could identify priming of suppletive allomorphs. We did this using a case of inflectional suppletion in Hebrew where the same person and agreement features are realised differently in different tenses. While Experiment 4.1 yielded no meaningful results because of issues with the design, Experiment 4.2 found a statistically significant ($p<0.05$) priming effect for 1st person plural verbs in different tenses, despite the different morphophonological realisations of these features, respectively the suffix *-nu* in the past tense and the prefix *n-* in the future. The present chapter thus reveals initial evidence that priming can detect shared morphosyntactic structures independently of morphophonological similarity.

Chapter 5

Root allomorphs

5.1 Root allomorphs in Italian

In chapter 4, we looked at a case of allomorphy in the inflectional domain, namely the different phonological realisations (*-nu* and *n-*) of the same morphosyntactic feature, 1st person plural, in Hebrew. In this chapter, we look at a case of root allomorphy, where the same morphosyntactic root is realised differently in different contexts. Before describing root allomorphy in Italian, it will be useful to review a few facts about Italian verb forms. In regular verbs, the third singular present tense form of the verb is the basis on which all other verb forms are derived. As shown in (1), it is made up of the spell out of the root, in this case, /am-/, and a thematic vowel, in this case /a/, with no overt person or number ending. As we have seen in Chapter 2, thematic vowels do not have any semantic meaning or syntactic role, and just signal to what conjugational class every verb belongs.

(1) *am-a*

love-THEME

'(he/she/it) loves'

The past participle form of the same verb is derived by adding a suffix, namely *-t-*, and a gender and number ending, as in (2). As should be clear from (1-2), the spellouts of the root and the theme vowel stay the same in the base form and the past participle.

(2) *am-a-t-o*

love-THEME-PAST.PART-MASC.SING

'loved (singular masculine past participle)'

In Italian, there are also irregular verbs, where the same morphosyntactic root is spelled out differently in different tenses.[124] In (3), we can see that the same root is spelled out as /ved-/ in the base form and as /vist-/ in the past participle.[125]

(3) a. ved-e

see-THEME

'(he/she/it) sees'

b. vist-o

see-MASC

[124]Many of these roots were already irregular in Latin and stayed so in Italian and the other Romance languages (see Maiden [2018] and Calabrese [2023] for in-depth overviews of the developments from Latin to the Romance languages in this respect).

[125] As pointed out by Calabrese (2015), roots that have an irregular past participle always have an irregular simple past, while the opposite is not necessarily true. However, for the purposes of this chapter, we will focus only on the base form and the past participle form, and we will not consider the simple past form, since, in spoken varieties of Italian, the use of simple past is restricted to Southern Italy (Bertinetto and Squartini 2016 and references therein).

'seen (masculine)'

There are two things to notice about (3b): first of all, that there is no thematic vowel in this form and, indeed, many irregular verbs do not have a thematic vowel in their past participle forms. Secondly, the form /vist-/ could be potentially further analysed as morphophonologically complex, such that /vis-/ would be the spellout of the root and /-t-/ is the spell out of the past participle, as shown in (4).

(4) vis-t-o
    see-PAST.PART-MASC
    'seen (masculine)'

While many irregular past participles have a /-t-/ suffix, not all of them do and some instead have a /-s-/ suffix instead, as shown in (5).

(5) a. prend-e
        take-THEME
        '(he/she/it) takes'

    b. pre-s-o
        pick-PAST.PART-MASC
        'taken (masculine)'

As we will see in the next section, there is disagreement on whether /-t-/ and /-s-/ are suffixes or whether they are part of the spellout of the root.

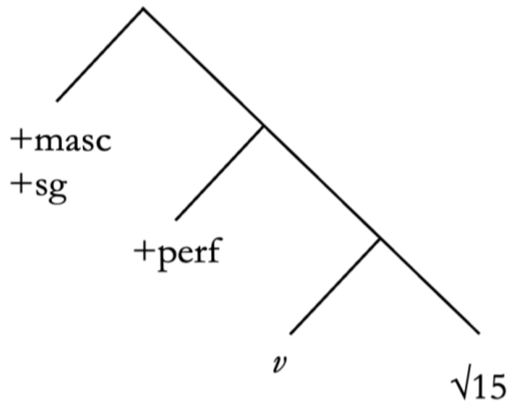
There is one more thing to notice about Italian irregular roots before moving to possible analyses. Italian irregular roots often co-occur with prefixed prepositions. For instance, the root *mettere/messo* is found in the prefixed verbs *promettere/promesso* and *trasmettere/trasmesso*. The meaning of the prefixed verbs is not predictable from (and often unrelated to) the meaning the root has when it occurs on its own. For instance, *mettere/messo* means 'to put', while *promettere/promesso* means 'to promise' and *trasmettere/trasmesso* means 'to transmit'. Moreover, some of the irregular roots simply cannot stand as verbs on their own and only occur with a prefix: for instance, *comprimere/compresso* is composed of a prefix *con-* and a root spelled out as *prim/press*, but **primere/presso* with no prefix is not attested in the language. In these cases then, the root in isolation does not have an identifiable meaning.[126]

5.2 Possible analyses

When analysing irregular verbs in Italian, we are faced with 2 questions. First of all, whether they are cases of root suppletion or root allomorphy. The second issue is whether we need to segment past participle forms into the spellout of the root and the spellout of the perfective head or not. Different analyses will result from different answers to these questions. We review them in turn. Let us start with the syntactic structure of past participles, which will look something like (6).

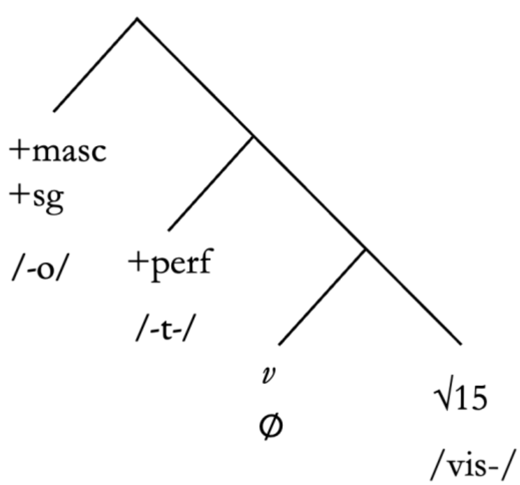
[126] This is exactly parallel to the English cases like *conceive/concept* or *deceive/deception*, where the root spelled out as **ceive/cept* is attested only with prefixes, and does not have a meaning on its own.

(6)



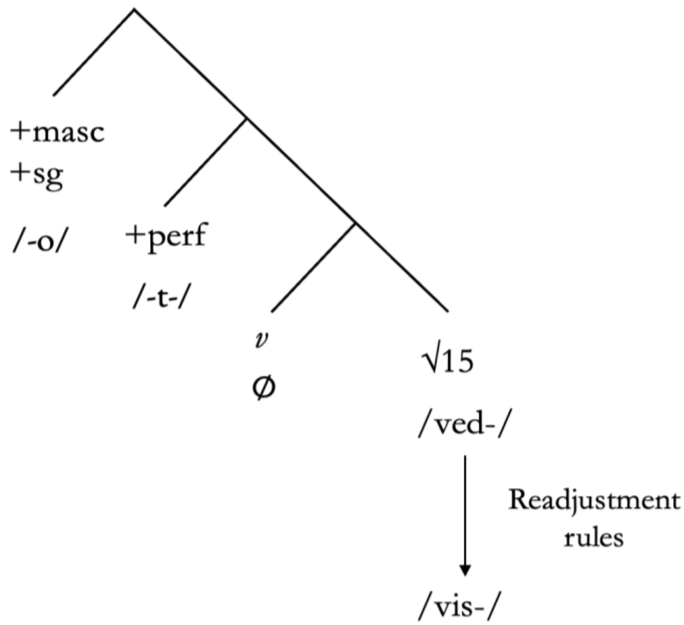
Now, let's think about how DM would analyse these cases. As we have seen in Chapter 2, the tendency in DM is to separate morphophonological forms in as many pieces as possible. Thus, /vis-/ would be considered the spellout of the root and /-t-/ the spellout of the perfective head. The question then is whether /ved/ and /vis/ are two different morphophonological realisations of the same root, i.e., whether this is a case of suppletion, or whether /vis/ is derived from /ved/ morphophonologically, thus constituting a case of root allomorphy. The suppletion analysis is shown in (7). To the best of my knowledge, no one has put forward such an analysis in DM.

(7)



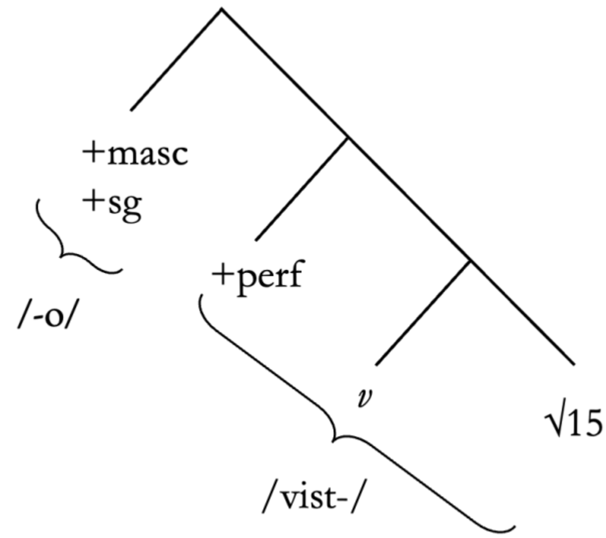
On the other hand, the allomorphy analysis is shown in (8). In this analysis, the morphosyntactic root √15 is always spelled out as /ved/ and then turned into /vis-/ after Vocabulary Insertion via Readjustment rules (see section 2.4.3.1). This is the analysis put forward in great detail in Calabrese (2013, 2015).

(8)



On the other hand, the other approaches to morphology reviewed in Chapter 2 would probably treat /vist-/ as a unitary morphophonological object which spells out various morphosyntactic heads. In other words, they would all adopt a suppletion analysis. In (9), I show how this would work in Spanning and Non-isomorphism.

(9)



In Nanosyntax, the technicalities of how syntactic structure is spelled out will differ due to Spellout-driven Movement and re-lexicalisation (see 2.4.4.1), but the gist of the analysis would be similar. A-morphous morphology obviously wouldn't assume a syntactic tree for the internal structure of a past participle, but Anderson (1992: 133) makes it clear that different stems are associated with different morphosyntactic features.[127] Thus, for our purposes, the analysis in A-morphous morphology wouldn't differ radically from the analysis in (9).

Let us now think about how the allomorphy and the suppletion analyses differ in representational terms. In the suppletion analysis, /ved-/ and /vis(t)/ are two different morphophonological realisations of a morphosyntactic root (and, possibly, of higher syntactic material).

[127] Maiden (2011, 2018), who adopts an A-morphous morphology world view but is less concerned with morphosyntactic features than Anderson (1992), seems to argue for a suppletion analysis. On the other hand, Aronoff (1994: Ch 2), who investigates Latin roots from which the Italian ones are derived, claims that the same lexeme can be realised by different stems. Interestingly, while Aronoff (1994: 41-44) clearly says that in the majority of cases the different Latin stems are predictable and thus should be derived from one another via rules, he does not give those rules nor clarifies whether irregular verbs should also be derived by rules or not. In other words, it is unclear whether Aronoff (1994) would favour a suppletion analysis or an allomorphy analysis.

Thus, the only representation /ved-/ and /vis(t)/ share in this analysis is syntactic. In the suppletion analysis instead, the two morphophonological representations are completely unrelated and, thus, the fact that the two forms of the root share segmental content is just an accident. In a root allomorphy analysis, instead, the past participle form is derived from the base form of the root morphophonologically. In this analysis, the past participle form and the base form share not only a morphosyntactic representation, but also the morphophonological realisation of the root. The surface form for the past participle is then obtained from the shared representation via the use of readjustment rules. The experiment conducted in this chapter cannot adjudicate among these analyses. However, all of these analyses assume that there is an abstract morphosyntactic element, namely the root, shared by the past participle and base form, which is what the present experiment tries to get at.

5.3 Previous studies

Prefixed irregular verbs in Italian allow us to test two different things at once: first of all, whether allomorphs of the same root can prime each other and, secondly, whether they can do so when the verbs they are embedded in have different meanings. Let us review priming evidence for each factor independently.

Priming of root allomorphs has been widely investigated in the visual priming literature. Stanners et al. (1979) and Fowler et al. (1985), using overt visual priming, find that a root primes its derivatives, whether they are regular (*predict* → *predictable*) or irregular (*persuade* → *persuasive*). Moreover, quite a few masked priming experiments showed priming for irregular verbs in English

(Crepaldi et al., 2010; Forster et al., 1987; Kielar et al., 2008; Meunier and Marslen-Wilson, 2004; Pastizzo and Feldman, 2002). Interestingly, Stockall and Marantz (2006) observed priming between allomorphs of the same root only when the base form was the prime (*teach* → *taught*) and not in the opposite direction (*taught* → *teach*). However, this could be due to the fact that theirs is an MEG experiment with a lower number of participants than other behavioural experiments, potentially lacking statistical power to identify this effect. The number of auditory priming studies investigating root allomorphy is much more limited and shows conflicting results. Kempley and Morton (1982) show root priming in regular but not irregular verbs and nouns. On the other hand, Marslen-Wilson and Zhou (1999) find priming between allomorphs of the same root (*sanity* → *sane*). In these experiments, the root allomorphs are always related in meaning at least to some degree.

Priming of roots having different meanings has been widely investigated in Semitic languages, but less so in other languages. Priming between words with the same root is found even when they have different meanings in visual only, auditory only and cross-modal experiments (Boudelaa and Marslen-Wilson 2000, 2005, 2015; Frost et al., 1997, 2000; Deutsch et al., 1998; Geary and Ussishkin 2019). Similarly, Creemers et al. (2020), in an auditory experiment on Dutch, find priming between a prefixed and unprefixed form of the verb, whether they are related in meaning (*aanbieden* 'to offer'→ *bieden* 'to offer') or not (*verbieden* 'to forbid'→ *bieden* 'to offer'), compared to an unrelated control (*opjagen* 'to hurry'→ *bieden* 'to offer').

The experiment that is closest in spirit to the one presented here is Experiment 1 in Boudelaa and Marslen-Wilson (2004), which used cross-modal priming. There, they test whether there is priming between different allomorphic forms of the same root in Arabic, whether they share the same meaning or not. In order to be able to have all the possible comparisons, they use different targets for each condition and compared each to a different control. They had 4 different conditions. In the first condition, they tested simple root priming, with prime and target sharing the same allomorph and the same meaning (*muʃaarikun* 'participant' → *ʃaaraka* 'participate'. In the second condition, they test whether different allomorphs of the same root (in this case, *w-f-q* and *t-f-q*) prime each other when they have the same meaning (*ʔittifaaqun* 'agreement' → *waafaqa* 'agree'). In the third condition, prime and target have not only different allomorphs of the root (in this case, *t-ʒ-h* and *w-ʒ-h*]) but also different meanings (*ʔittiʒaahun* 'destination' → waaʒaha 'confront'). Finally, they had a phonological condition in which prime and target share two or three consonants, but not a root (*fatratun* 'period' → *fattaʃa* 'search'). They find a significant facilitarory effect in all the root conditions, but not in the phonological condition.

Summarising, in the past, root priming has been identified both in cases where the form of the root changes (*teach* → *taught*) as well as in cases where the form of the root stays the same, but the meaning changes between prime and target (*verbieden* 'forbid'→ *bieden* 'offer'). The current study allows us to manipulate both meaning and form in the same experiment. Indeed, in our experiment the same root occurs in both primes and targets, but with a different morphophonology and a different meaning (*trasmettere* 'transmit' → *promesso* 'promised'). The additional difference from previous studies is that both primes and targets are prefixed verbs (differently from Creemers et al. (2020) where only the prime was a prefixed verb).

5.4 Experiment 5.1

In this experiment, we want to establish whether it is possible to obtain priming of root allomorphs in the auditory modality, independently of root meaning. We address this question by testing whether two prefixed verbs containing different allomorphs of the same root prime each other (*trasmettere* 'transmit' → *promesso* 'promised'). To be sure that it was indeed possible to identify priming of root allomorphs in the auditory modality, we also had a condition in which prime and target are two different forms of the same prefixed verb (*promettere* 'promise' → *promesso* 'promised'). We compared both conditions to an unrelated condition, where the prime was a complex verb with a different root and different prefix (e.g., *confidare* 'confide' → *promesso* 'promised').

5.4.1 Methods

5.4.1.1 Materials

The critical stimuli that form the targets in this experiment were 36 complex irregular past participles.[128] 22 targets had roots that can stand as verbs without a prefixed preposition (e.g. *promettere/promesso* 'to promise/promised' from *mettere/messo* 'to put/put (past participle)'), while 14 had roots that only occurred prefixed (for example, *comprimere/compresso* from **primere/presso*, which does not occur in the language without a prefix). Even though all targets were past participle forms, some

[128] We chose past participles as our targets given the results in Stockall and Marantz (2006) where directionality seems to matter (regular → irregular vs irregular → regular).

of the forms can also be used as adjectives or nouns, and one of them *presunto* ‘alleged’ can only be used as an adjective. However, since we are interested in priming of the morphosyntactic root, lexical category of the prime shouldn’t matter. Each target was combined with 3 different primes to create 3 experimental conditions, resulting in 108 prime-target pairs. These were distributed across 3 experimental lists in a Latin Square design, such that each list contained 36 prime-target pairs (12 from each of the 3 conditions) and no target was repeated in any given list. Mean number of syllables for targets was 3.1. Mean duration of the target audiofiles was 981ms, and was included in the model as a predictor of target RT (see section 5.4.2.2)

In the root and prefix condition, the prime was the infinitive form of the target past participle: *promettere* ‘to promise’ → *promesso* ‘promised’. In this condition, prime and target were two allomorphic forms of the same root, but they also shared the same prefix and, thus, have the same meaning. We inserted this condition to be sure that it is indeed possible to have priming of root allomorphs when keeping meaning the same. Mean number of syllables in this condition was 4.

In the root only condition, the prime is the infinitive form of a complex verb derived from the same root as the target: *trasmettere* ‘to transmit’ → *promesso* ‘promised’. Since these are irregular verbs, the amount of phonological overlap between prime and target is extremely reduced. Prime target pairs in this condition were chosen such that they were semantically unrelated, despite sharing the same morphosyntactic root. In this condition, the mean number of syllables was 3.9.

In the unrelated condition, primes were regular complex infinitive verbs with a different root and preposition (e.g., *confidare* ‘confide’ → *promesso* ‘promised’). Verbs in this condition were chosen such that their root occurred with at least one other preposition to create a complex verb (e.g., root: *fid*, *con-fid-are* 'confide', *affidare* 'to entrust', *diffidare* 'distrust'). Complex verbs were used in this condition to match as closely as possible primes in the other two conditions. In this condition, 7 primes had roots that can stand alone as verbs without preposition (e.g. *confidare* 'confide' from *fidarsi* 'to trust'), while 5 had roots that only occurred prefixed (e.g., *insultare* 'to insult' from **sultare,* which does not occur in the language without a prefix). Mean number of syllables in this condition was 4.1.

Table 5.1 presents examples of the stimuli used. The full list of critical items can be found in Appendix C.

<table>
<tr><th>Condition</th><th>Prime</th><th>Target</th><th>Root</th></tr>
<tr><td>1. Root and prefix</td><td>pro-mett-ere</td><td rowspan="3">pro-mess-o 'promised'</td><td rowspan="3">mett/mess</td></tr>
<tr><td>2. Root only</td><td>tras-mett-ere
'to transmit, pass down'</td></tr>
<tr><td>3. Unrelated</td><td>con-fid-are
'to confide, trust'</td></tr>
</table>

Table 5.1: Experiment 5.1: design and sample stimuli.

Since primes and targets in the Root and prefix condition share not only the root but also the prefix, we calculated mean phoneme overlap for each condition. Targets and primes were on average 8 segments long. Mean phoneme overlap was calculated as phonemes of the root as well as other phonemes that might be shared between prime and target (*trasmettere* → *promesso*, root phoneme overlap: *me*, other shared phonemes: *r, s*). Different allophonic realisations of the same phoneme /s/, which is realised as [z] when intervocalic and [s] in all other contexts, were considered as the same phoneme. Geminates were considered as one phoneme. Mean phoneme overlap was much greater in the Root and prefix condition (4.6 phonemes) than in Root only condition (3.3 phonemes) and the unrelated condition (2.6 phonemes).

Frequencies for all primes and targets were extracted from the SUBTLEX-IT database containing ~130M tokens (Crepaldi et al., 2015). There are three different measures in the SUBTLEX-IT: raw frequency for individual wordforms, contextual density for individual wordforms and raw frequency for dominant lemma. The measure of frequency used here was contextual density, i.e., the number of different movies that a wordform appears in, since this was shown to be a better predictor of response time than raw frequency (Adelman et al., 2006; Soares et al., 2015). Contextual density was preferred to lemma frequency for various reasons. First of all, as noted above, some of the past participles can also be adjectives or nouns. Since only wordforms with the same lexical category are counted under the same dominant lemma, use of the past participle form as adjective or noun are not counted towards the verb dominant lemma. Using lemma frequency would thus have excluded important data. Moreover, there were inconsistencies on how the dominant lemma was identified for different forms thus making contextual density preferrable. Mean log10 frequency was 2.21 in the Root and prefix condition, 2.37 in the Root only condition and 2.28 in the unrelated condition. Frequencies for targets were added as predictors in the regression model (mean log10 target frequency was 2.5).

To prevent strategic effects, we furthermore included 264 filler pairs, so that critical prime-target pairs make up only 12% of all items. The total number of items thus amounted to 600 items, 50% of which were real words and 50% non-words. There were 66 filler verbs (either infinitives or past participles) and 162 filler nouns. Non-words were created in such a way to resemble nouns and verbs (either infinitive or past participle verbs). They were created by starting from a real word, always keeping the first syllable(s) intact and then changing one or more syllables starting from the end. The majority of the pseudoverbs still maintained verbal endings, but ⅕ of them differed from real words by changing the last syllable. These non-words were morphologically more similar to nouns since in Italian the final syllable is also what identifies infinitives and past participle as verbs.

Non-words were created modifying existing words to encourage participants to listen till the end of words before they knew for sure if they heard a real word or not, hopefully ensuring that they were listening to the whole audio file before making their lexical decision. Since all the irregular prime verbs belonged to the *-ere* conjugation and the irregular past participles often ended in *-to* (with no thematic vowel) or *-so* (see sections 5.1 and 5.2), 27 pseudo-infinitives ended in *-ere*, 17 pseudo-past participles ended in *-to* (with no thematic vowel) and 17 in *-so*.[129] This was done to ensure that pseudoverbs matched the real verbs in the experiment as much as possible. Pseudonouns were also created starting from real nouns, with ⅕ of them differing from real nouns only in the last syllable, once again to ensure that participants had to listen till the end of a word before making a decision.

[129] As we have seen above, the regular past participles ending in Italian is *-to* with *-a-* and *-i-* as thematic vowels. Instead, irregular past participle endings are often *-so* or *-to* , but generally they do not have a thematic vowel (see Calabrese 2015).

The stimuli were recorded by an adult female native speaker of Italian with a high-quality microphone (AKG C480b, capsule CK69 ULS), in a sound attenuated booth. Audiofiles were segmented using Praat (Boersma and Weenink 2015) and normalised to a peak amplitude of 70 dB SPL.

5.4.1.2 Participants

Using the online experiment platform Prolific, we recruited 150 participants (50 for each condition) that identified as native speakers of Italian living in Italy. They were paid 7.50$ for their participation in the experiment, which lasted approximately 30 minutes.

5.4.1.3 Procedure

The procedure was the same as in Experiments 4.1 and 4.2, but it's repeated here for the sake of convenience. The experiment was conducted online using the Penn Controller for Internet Based Experiments (PCIbex) (Zehr and Schwarz, 2018). All stimuli were presented auditorily. A continuous lexical decision task was used, so that a response was provided to both primes and targets, as illustrated in Figure 5.1. The distinction between primes and targets was thus not made explicit to participants.

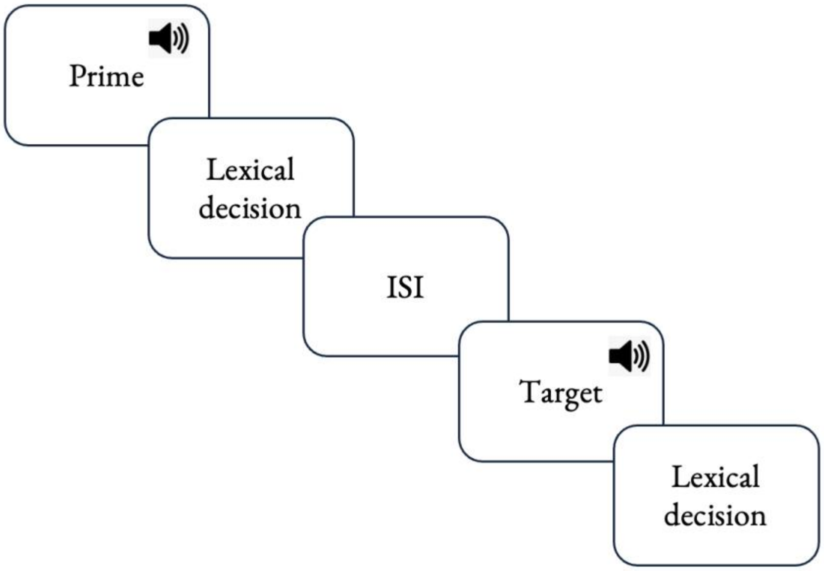


Figure 5.1: Continuous auditory lexical decision (Goodwin Davies 2018: 23).

The task had a random inter-stimulus interval between 400-600ms to prevent participants from responding rhythmically. The ISI was measured from the end of the sound file or participant response, whichever was later. Stimuli presentation was pseudo-randomised throughout the experiment for each participant such that critical prime target pairs occurred at the maximum possible distance from each other. The experiment consisted of 3 blocks with the possibility for a self-administered break after each block, and a practice trial of 24 items (50% of which were nonwords) at the beginning of the experiment in which participants were familiarised with the task and were provided feedback on each response. At the beginning of the experiment, participants were instructed that they would hear existing and non-existing Italian words, and that they had to make a lexical decision to each word as fast and as accurately as possible. Responses of 'word' and 'non-word' were recorded from keyboard (F and J) button presses. Participants were instructed to use headphones during the experiment.

5.4.2 Analysis

5.4.2.1 Data trimming

Mean accuracy by subject (as calculated on both critical and filler items) was extremely high (97.6%) and the participant with the lowest accuracy had an accuracy of 87.8%, so no participant was excluded on the basis of low accuracy. Trials with incorrect responses to primes or targets were discarded, which led to an exclusion of 178 data points out of a total of 5400 trials (36 targets * 150 participants). All targets with outlier RTs (<500ms and >2500ms) were excluded, as well as the targets for which the prime had an outlier RT (<500ms and >2500ms). This led to a further exclusion of 124 data points. In total, the data trimming process led to the exclusion of 302 observations, or 5.6% of the data.

5.4.2.2 Modelling

The data were analysed as follows. Responses were coded for response type (word/non-word) and response time (RT; measured in ms from the onset of the sound file). RT data were then log10-transformed. We analysed effects on log10-transformed RTs (our dependent variable) with linear mixed-effects models, using the lme4 package (Bates et al. 2015, version 1.1-37) in the R environment (R Core Team 2024, version 4.5.0). We first fit a model that included a random slope for subject and a random intercept for target items. Since this model was singular, we fit a new model including random intercepts for subjects and target items. The following fixed effects were included in the model: Condition (Root and prefix; Root only; unrelated), Trial Number, Target Frequency, Target Duration and Prime RT. Trial Number and Target Frequency were chosen because they are generally known to influence Target

RT. Target duration was inserted given the auditory nature of the experiment. Similarly, Prime RT was included because it was shown to have a direct impact on target RTs in similar experiments (Creemers et al., 2020, Gaston et al., 2021; Goodwin Davies and Embick, 2019, Loui et al., 2021; White et al., 2024). Condition was treatment coded with the unrelated condition as the reference level. Target Frequency, Target Duration and Prime RT are log10 transformed and z-scored, while Trial Number was z-scored. P-values are determined using the package lmerTest (Kuznetsova et al. 2016); significant p-values are reported at $p < 0.05$.

5.4.3 Results

Table 5.2 gives the raw RT data, and Figure 5.5 illustrates the log-transformed RT data on which analyses were performed. Table 5.3 shows accuracy rates. Target RTs in the Root and prefix condition and in the Root only condition were respectively 81ms and 14ms faster than in the Unrelated condition. The mixed-effect model of the log10-transformed RT data revealed significant facilitation in the root and prefix condition, but not in the root only one. Table 5.8 shows the model summary and reports the model formula (a best practice suggested by Meteyard and Davies [2020]).

Condition	**Target RT**	**Priming effect**
1. Root and prefix (*promettere - promesso*)	1371ms (251)	-81ms
2. Root only (*trasmettere - promesso*)	1438ms (252)	-14ms
3. Unrelated (*confidare - promesso*)	1452ms (247)	N/A

Table 5.2: Mean response times to the targets (in ms), priming effects (in ms). RTs are measured from the onset of the sound file. Priming effect is the RT for each condition minus the RT in the unrelated condition. Standard deviations are given in parentheses.

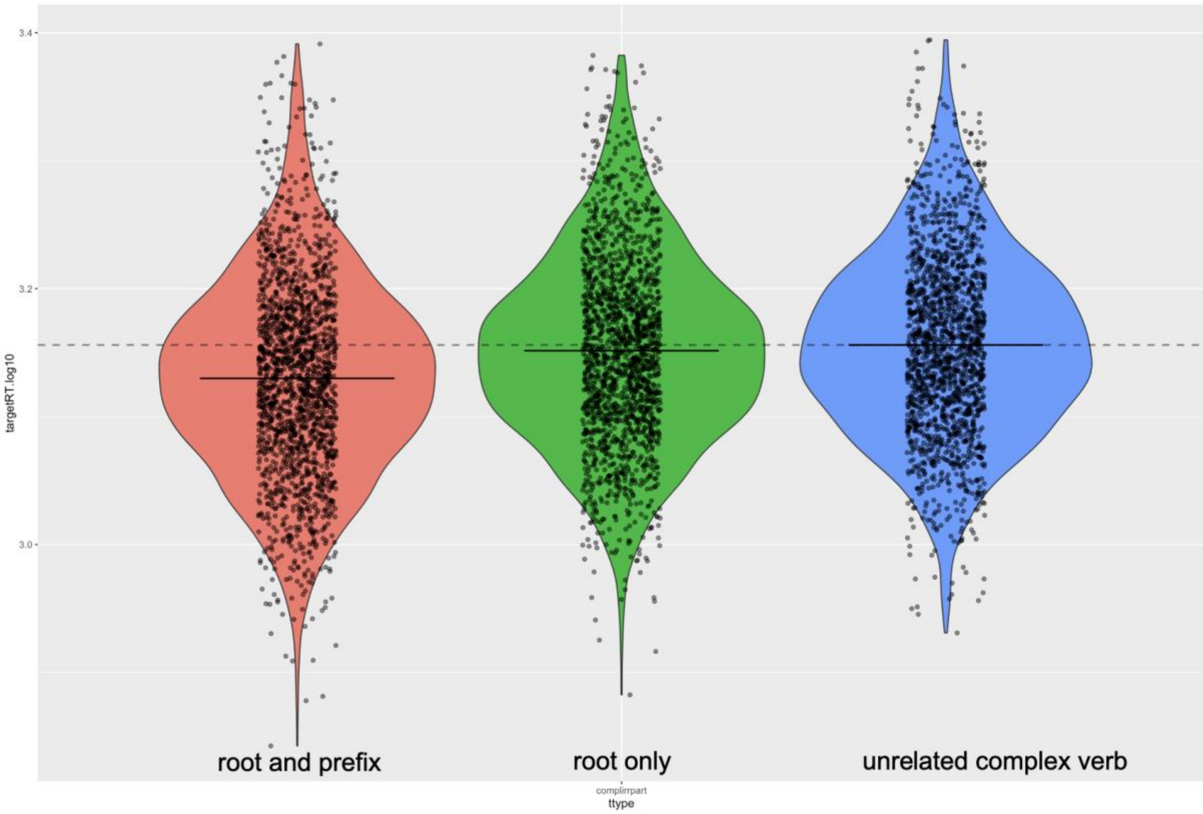


Figure 5.2: Violin plots of the log-transformed response times in Experiment 5.1 for the Root and prefix; Root only and unrelated conditions. Black horizontal lines represent means by condition, dotted grey line represents the mean in the unrelated condition.

	% accuracy	
Condition	**Primes**	**Targets**
1. Root and prefix (*promettere - promesso*)	98%	99.5%
2. Root only (*trasmettere - promesso*)	98.1%	98.4%
3. Unrelated (*confidare - promesso*)	98.1%	97.9%

Table 5.3: Error rates (number of incorrect responses) to targets and primes per condition.

		Log10 transformed RTs	
Fixed effects	*Estimate (β)*	*CI*	*p-values*
Intercept	3.154	3.148 – 3.16	**<.001**
Prime type			
Root and prefix vs. Unrelated	-0.021	-0.025 – 0.018	**<.001**
Root only vs. Unrelated	-0.002	-0.006 – 0.001	0.183
Trial Number	5.4E-04	-0.002 – 0.003	0.7
Log10-transformed Target Frequency	5.4E-04	-0.004 – 0.003	0.743
Log10-transformed Target Duration	0.021	0.018 – 0.025	**<.001**
Log10-transformed Prime RT	0.03	0.028 – 0.031	**<.001**
Random effects	*N*	*Variance*	*SD*
Subject	150	8.5E-04	0.029
Targets	36	9E-05	0.009
Residual		0.002	0.049
N Datapoints			5098

Table 5.4: Experiment 5.1: Model summary. Model formula: targetRT.log10 ~ prime_type + zTrialNum + zLog10_targetfreq + zLog10TargDur + zLog10_PrimeRT + (1 | Subj) + (1 | target)

5.5 Discussion

In this experiment, we wanted to determine whether it is possible to obtain priming of root allomorphs. We tested this in two different conditions. In the Root and prefix condition, prime and targets contained different allomorphs of the same root, but also shared a prefix and thus the same meaning. This condition was inserted to establish whether priming of root allomorphs can be identified at all in the auditory modality. In the Root only condition, primes and targets contained different allomorphs of the same root, but also had different prefixes and thus different meanings. This condition was more directly testing whether it is possible to prime the shared morphosyntactic root regardless of semantic and morphophonological similarity.

We identified a very substantive priming effect between verbs that had different allomorphs of the same root but had the same prefix, and thus the same meaning (*promettere* 'to promise' → *promesso* 'promised'). Priming in this condition could have been due to various factors. First of all, prime and target share the same morphosyntactic structure, same prefixal preposition and same root. Moreover, prime and target have a lot of phonological overlap (4.6 phonemes), since they share the prefix and the phonemes that are in common between the two allomorphs of the root. Finally, prime and target have the same meaning (*modulo* the differences in meaning between infinitive and past participle of the same verb). These results show that it is possible to have priming of different allomorphic forms of the same prefixed verb. As we have seen in section 5.3, in the auditory modality, priming of root allomorphs was found in Marslen-Wilson and Zhou (1999), but not in Kempley and Morton (1982). Thus, the present results confirm that different allomorphs of the same root can prime each other auditorily, by moreover probing this phenomenon in a language that hadn't been investigated before in this respect, namely Italian.

In the Root only condition (*trasmettere* 'transmit' → *promesso* 'promised'), the numerical difference between target RTs in this condition and the unrelated condition (-14ms) did not reach significance. There are multiple possible explanations for this. First of all, it could be that the effect in this condition was too small to reach significance with the present sample size. Thus, repeating the same experiment with a bigger sample size would be necessary to rule out this possibility. Another possibility is that Italian irregular verbs are not morphosyntactically complex in current stages of the language. In other words, speakers might represent these verbs as not being made up a preposition (spelled out as /pro/) and a root (spelled out as /met:/ or /mes:/), but only of a root (spelled out /promet:/ or as /promes:/). There might even be individual differences in this respect, with some speakers preferring the morphosyntactically complex analysis and others preferring the simplex one. In this scenario, the morphosyntactic priming of the root for some participants could be dampened by its absence in other participants.[130]

It is also possible that the numerical difference between the Root only condition and the Unrelated condition could be due to mere random variance. If that's the case, the results in this experiment differ from the ones in Experiment 4.2 and Experiment 6.1 (see in Chapter 6), where we much more clearly identify morphosyntactic priming independently of phonological similarity. Further experiments should be conducted to better understand the different factors that might have contributed to a priming effect in the root and prefix condition. For instance, the impact of meaning on our experimental results could be teased apart by designing a condition in which prime and target share the

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[130] This is not necessarily in contrast with the analyses provided in section 5.2. Indeed, as we have seen in Chapter 2, footnote 73, there is no direct way to deduce what constitutes a syntactic atom in a language. Instead, both linguists and children acquiring the language have to postulate an analysis by relying on evidence coming from meaning and form. The analyses reviewed above 'favour' the phonological evidence: since forms like *trasmettere/trasmesso* and *promettere/promesso* show the same alternation (*mett/mess*), analysts propose to treat this as the realisation of a shared morphosyntactic root/stem (and possibly higher morphosyntactic structure). However, a different possibility is available: if meaning is favoured, *promettere* and *trasmettere* could be analysed as spelling completely different roots despite the morphophonological similarity. The first analysis requires the postulation of a smaller number of roots and captures the generalisation that the form changes happens irrespective of the identity of the prefix, and it is thus usually preferred by linguists. However, it seems to me that nothing rules out the possibility that (some) speakers prefer the second analysis.

same root allomorph, but have different prefixes and therefore different meanings (*trasmettere* → *promettendo*).[131] This would allow us to determine how much facilitation there is for sharing the same morphophonological realisation of the root in the absence of shared meaning. Another experimental manipulation would be to test priming between two different allomorphic forms of the same unprefixed verb (*mettere* → *messo*). While in this case prime and target share the same root and the same meaning, the amount of phonological overlap between the two forms is more reduced than in the experiment we ran since prime and target do not share a prefix. Summarising, future research is needed to determine the contribution of meaning and form to the priming effects we see in the root and prefix condition, and to further shed light on whether root allomorph priming independent of meaning similarity can indeed be identified.

5.6 Conclusion

In this chapter, we have seen different forms of the same prefixed verb can prime each other. However, since this effect could be due to also sharing a prefix and meaning, the results do not definitely prove root allomorph priming. Moreover, when prime and target only share different allomorphs of the same root, we only see a non-significant numerical tendency towards priming. Therefore, further experiments, with bigger sample sizes and in other languages too, should be conducted to determine whether it is possible to identify purely morphosyntactic priming of root allomorphs.

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[131] Using the present participle form *promettendo* instead of the infinitive *promettere* would rule out any potential rhyme prime effect.

Chapter 6

Homophonous affixes

6.1 Nominal and adverbial suffixes in Italian

In Chapter 4, we deployed the allomorphy found in the agreement system of Hebrew to determine whether priming could be driven by morphosyntactic features. In this chapter, to address the same question, we make use of a corner of Italian morphology where a case of accidental homophony occurs.[132] In Italian, many nouns show a suffix that spells out a nominalising head. For instance, the noun *creazione* 'creation' is derived from the verb *creare* 'to create' by adding a nominalising head, which is spelled out as *-zion-* and the gender/number ending *-e* (feminine singular), as shown in (1).[133]

[132] Questions by Simon Chervenak, an undergraduate in our department working on his B.A. thesis with Alex Krauska and Naomi Feldman, first made me realise this pocket of accidental homophony in Italian, which sparked in me the desire to investigate it experimentally. I am grateful to Simon for his thorough work which led to his questions and, unwittingly, to this experiment.
[133] *-zion-* has the same etymological origin as English *-tion*.

(1) $[[[[\textit{cre}]_{\text{root}}\ \textit{a}]_{\text{v}}\ \textit{zion}]_{\text{n}}\ \textit{e}]_{\text{Gend/Num}}$

Similarly, the noun *trattamento* 'treatment' is derived from the verb *trattare* 'to treat' by adding a nominalising head, which is spelled out as *-ment-* and the gender/number ending *-o* (masculine singular), as shown in (2).[134]

(2) $[[[[\textit{tratt}]_{\text{root}}\ \textit{a}]_{\text{v}}\ \textit{ment}]_{\text{n}}\ \textit{o}]_{\text{Gen/Num}}$

In both cases we have a nominalising head that is turning a noun into a verb. These data can be analysed in two ways. One way is to assume that the same syntactic head is spelled out by two different morphophonological realisations. The other is to assume that there are two different syntactic heads, let's call them n_1 and n_2, which are spelled out respectively as /-ment-/ and as /-tsjon-/. Whatever the correct analysis of these data, what the nominalising head(s) that are spelled out as /-ment-/ and as /-tsjon-/ have in common is that they turn a verb into a noun.

By pure accident, in Italian, the morphosyntactic head that turns adjectives into adverbs is spelled out as *-mente*, as shown in (3).

(3) $[[[[\textit{pubblic}]_{\text{root}}\ \textit{a}]_{\text{Adj}}\ \textit{mente}]_{\text{Adv}}$

While *-ment-* and *-mente* spell out completely different morphosyntactic heads, they are phonologically very similar, sharing 4 segments. This is just an accident of the language, but it allows us to test directly

[134] Needless to say, *-ment-* has the same etymological origin as English *-ment*.

and in the same experiment whether priming is more sensitive to sharing morphosyntactic features or their morphophonological realisation, which is the overarching theme of this dissertation.

6.2 Previous studies

As already noted in Chapter 3, the number of studies investigating affix priming are extremely reduced compared to root priming. The only study using auditory-auditory priming investigating derivational priming is Emmorey (1989). As we have seen in Chapter 4, Exp. 2 and 3 in that paper show that a significant priming effect of more than 60ms is found only when prime and target share the last syllable whether they share a suffix (*shortness*→ *blackness*) or not (*tango* → *cargo*). Emmorey (1989) also finds a statistically non-significant facilitation effect of less than 30ms when prime and target rhyme whether they share a suffix (*smiling*→ *breaking* in Exp. 2 and 3) or not (*baloon*→ *saloon* in Exp. 1). Thus, Emmorey's (1989) results favour a phonological origin of the priming effect. The other studies looking at derivational priming are either cross-modal priming studies or visual priming studies. In what follows, I report on these, while aware that the difference in modality might be a contributing factor towards presence or absence of derivational affix priming.

In a cross-modal priming paradigm, Marslen-Wilson et al. (1996) investigated derivational affix priming looking at both suffixes and prefixes (*darkness*→*toughness*, *rearrange*→*rewrite*). Over two experiments, they showed robust priming (of around 30ms) for productive suffixes (*-ation*, *-able*, *-ness*) as well as productive prefixes (*re-*) relative to an unrelated control.[135] On the other hand, unproductive suffixes (*-ment*, *-al*, *ate*) and prefixes (*en-*, *in-* and *mis-*) showed a reduced facilitation relative to an unrelated control, which was statistically significant only in Experiment 2. While influenced by affix productivity, these results show initial evidence of derivational affix priming.[136] Indeed, various studies using a masked visual priming paradigm show derivational affix priming. For instance, as we have seen in Chapter 3, Duñabeitia et al. (2008) report priming of the nominalising affix *-dad* in Spanish (*brevedad→igualdad*). Crepaldi et al. (2016) show that a nonword containing a derivational suffix primes a real word with the same derivational suffix (*sheeter→teacher*). Using an overt visual priming paradigm coupled with continuous lexical decision, Gaston et al. (2021) demonstrated priming of derivational affixes both when the prime directly precedes the target and when there are as many as 33 items intervening between them (long-lag priming), replicating results in vanWagenen (2014).

Before moving on, it is worth mentioning three more studies, namely Smolík et al. (2010), Goodwin Davies and Embick (2019) and White et al. (2024). While these studies involve inflectional rather than derivational affixes, they have similar experimental manipulations to the one used here and thus are relevant to the present discussion. Moreover, both Goodwin Davies and Embick (2019) and White et al. (2024) constitute a close antecedent to the present experiment since they use the same continuous auditory-auditory lexical decision task as the one used here.

[135] They take an affix to be productive if it is still used in current stages of the language to create new words.

[136] Reid and Marslen-Wilson (2000) show priming of diminutive affixes among nouns and perfective affixes in verbs. While they treat these as derivational affixes, these are cases where the line between derivation and inflection is blurred (notice that in all morphological theories reviewed in Chapter 2 apart from A-morphous morphology, there is no formal distinction between derivation and inflection).

As we have seen in Chapter 4, Smolík (2010) tests whether in Czech a masculine accusative/genitive noun ending in *-a* can prime a feminine nominative noun with the same ending (*syna* 'son.masc.acc/gen' → *váha* 'weight.fem.nom'). When the prime is shown for 50ms, there is no priming effect in this condition as compared to a baseline. However, when the prime is shown for 150ms, there is a robust priming effect in this condition. Smolík's (2010) also find a significant, but smaller priming effect where prime and target are both feminine nominative nouns ending in *-a* (*líp-a* 'linden.fem.nom' → *váh-a* 'weight.fem.nom') as well as when the prime is a feminine nominative nouns ending in *-e* (*vůle* 'will.fem.nom' → *váh-a* 'weight.fem.nom'). While the results in Smolík (2010) are difficult to interpret, they cautiously show some evidence for priming across allomorphs.

Goodwin Davies and Embick (2019) compare priming between two plural primes (*crimes* → *trees*) and between a prime that whose final segment is /z/ and a plural target (*cleanse* → *trees*). They identify priming only in the first condition, providing initial evidence that morphosyntactic features matter more than phonological overlap to obtain a priming effect.

White et al. (2024) aimed to determine whether there is priming between different surface realisations of the English progressive *-ing* as /ɪŋ/ or /ɪn/. White et al. (2024) use various prime-target pairs in different experiments, but they are especially interested in cases whether priming can pick up a difference between words like *ceiling* and *talking*. *Ceiling* is not morphophonologically complex, and its root is spelled out as /silɪŋ/ or /silɪn/. Instead, words like *talking* are morphophonologically complex with the morphosyntactic root being spelled out as /tɔk/ and the progressive marker being realised as either /ɪŋ/ or /ɪn/. In their experiment 3, White et al. (2024) show that, when the progressive marker is realised as /ɪn/, the priming effect between *ceiling* and *talking* is much smaller than the one between *jumping* and *talking*, and that it isn't significant when the progressive marker is realised as /ɪŋ/. Similarly, White (2021) also shows that *dolphin* doesn't prime *talkin'*, despite the fact that they both end in /ɪn/. The results in White (2021) and White et al. (2024) cannot adjudicate on whether the origin of the priming is due to a shared morphosyntactic representation (progressive) or to its morphophonological realisation (/ɪŋ/ or /ɪn/), but they clearly rule out that priming could be due to a purely phonological overlap. The present experiment is similar in spirit to White et al. (2024), but uses primes and targets that are all morphosyntactically and morphophonologically complex to increase the possibility of priming between homophonous affixes. Moreover, we have a condition where prime and target are both deverbal nouns but they do not share any phonological overlap, allowing us to test directly whether the origin of the priming is morphosyntactic or morphophonological in nature.

6.3 Experiment 6.1

This experiment intends to compare priming effects of accidental homophony and morphosyntactic similarity. We address this question by testing how four different primes influence the processing of a plural noun target containing the suffix *-ment-* (*allenamenti* 'trainings'). In the first condition, the prime is a singular noun containing the same suffix *-ment-* as the target (*giuramento* 'oath' → *allenamenti* 'trainings'). We also test priming from a singular deverbal noun containing a different suffix, namely *-zion-* (*valutazione* 'evaluation' → *allenamenti* 'trainings'). In the third condition, we test priming from an adverb containing the suffix *-mente* (*giustamente* 'rightly' → *allenamenti* 'trainings').

In this condition, prime and target have the same amount of phonological overlap as in the first condition, but they are morphosyntactically unrelated, allowing us to tease apart the contributions of morphosyntax and morphophonology. Finally, we compare the previous three conditions to an unrelated condition, where the prime is an adjective unrelated to the target (e.g., *affidabile* 'reliable' →*allenamenti* 'trainings').

6.3.1 Methods

6.3.1.1 Materials

The critical stimuli that form the targets in this experiment are 48 plural nouns with the suffix -*ment-* (e.g., *allenamenti* 'trainings'), where *-ment-* is the morphophonological realisation of a nominalising head and *-i* is the morphophonological realisation of masculine plural. All target nouns were derived from a verb and were related in meaning to it (*allenamenti* 'trainings' from *allenare* 'to train'). Care was taken that all of the targets used in this experiment were commonly used in the plural. Mean number of syllables for targets was 4.8. Mean duration of the target audiofiles was 1143ms, and was included in the model as a predictor of target RT (see section 6.3.2.2).

Each target was combined with 4 different primes to create 4 experimental conditions, resulting in 192 prime-target pairs. These were distributed across 4 experimental lists in a Latin Square design, such that each list contained 48 prime-target pairs (12 from each of the 4 conditions) and each target appeared only once in a given list. In the first condition, which we can label +Syn+Phon, primes are 12 singular nouns that have the same suffix *-ment-* as the targets, but end in *-o* because they are singular, (e.g.

giuramento 'oath'). Similarly to targets, primes in this condition are nouns derived from a verb and are related in meaning to the verb they are derived from (*giuramento* 'oath' from *giurare* 'to take an oath'). In this condition, primes and targets not only have the same morphosyntactic structure (nouns derived from verbs), but they share the same nominalising head, which is realised by the same morphophonological piece, namely *-ment-*. By virtue of having the same nominalising head, they also have the same gender, i.e., they are both masculine (despite differing in number).

In the second condition, +Syn -Phon, primes are 12 singular nouns with the suffix *-zion-e* such as *valutazione* 'evaluation', where *-zion-* is the morphophonological realisation of a nominalising head and *-e* is the morphophonological realisation of feminine singular. Similarly to targets, primes in this condition are nouns derived from a verb and are related in meaning to it (*valutazione* 'evaluation' from *valutare* 'to evaluate'). In this condition, primes and targets have the same morphosyntactic structure (nouns derived from verbs), but their nominalising heads are spelled out by different phonological material in the 2 conditions, *-ment-* vs *-zion-*. As we saw in section 6.1, it is unclear whether, *-zion-* and *-ment-* are different morphophonological realisations of the same nominalising head, or whether these two suffixes also correspond to two different morphosyntactic heads. However, what is crucial for this experiment is that targets and primes in this condition share the same morphosyntactic structure: they are deverbal nouns. Differently from the first condition however, prime and target in this condition also have different genders (feminine for the prime and masculine for the target).

In the third condition, -Synt +Phon, primes are 12 adverbs that end with the suffix *-mente,* such as *giustamente* 'rightly', where *-mente* is the morphophonological realisation of an adverbialising head.

Primes in this condition are adverbs derived from adjectives and transparently related in meaning to them (*giustamente* 'rightly' derived from the adjective *giusto* 'right'). In this condition, primes and targets have completely different morphosyntactic structures (deadjectival adverbs vs. deverbal nouns respectively), but, due to pure accident, they share the same amount of phonological overlap as primes and targets in the first condition (/-ment-/). One additional thing to note is that in the targets *-ment-* is the full spellout of the nominalising head, while in primes *-ment-* is just part of the spell out of the adverbialising head, whose full form is *-mente*.

In the fourth condition, -Syn -Phon, primes are 12 singular deverbal adjectives ending with the suffix *-abil-e* and related in meaning to the verbs they are derived from. This condition constitutes a control condition, since primes and targets in this condition are completely unrelated.

Dominant lemma frequencies for all primes and targets were extracted from the SUBTLEX-IT database containing ~130M tokens (Crepaldi et al., 2015). Dominant lemma frequency was chosen instead of individual item frequency in order to avoid differences between nouns and adjectives on the one hand (which can be either singular or plural) and adverbs on the other (which are always invariable).[137] Primes were matched for log frequency listwise (mean log frequencies were as follows: +Syn+Phon condition: 2.7492, +Syn -Phon condition: 2.7679, -Synt +Phon condition: 2.7679 and -Syn -Phon condition: 2.7081). Primes in the different conditions were also matched for syllable length

[137] For two cases, namely *fraintendimento* and *gonfiabile*, the lemma frequency was not available. Thus, item frequencies for *fraintendimento* and *fraintendimenti*, and for *gonfiabile* and *gonfiabili* respectively were extracted and summed together to approximate lemma frequency.

as closely as possible: mean syllable length was 4.9 in the +Syn+Phon condition, 5 in the +Syn -Phon condition, 4.9 in the -Synt +Phon condition and 5.2 in the -Syn -Phon condition.

Table 6.1 presents examples of the stimuli used. The full list of critical items can be found in Appendix D.

Condition	**Prime**	**Target**
1. +Syn+Phon	*giuramento* 'oath'	*allenamenti* 'trainings'
2. +Syn -Phon	*valutazione* 'evaluation'	
3. -Synt +Phon	*giustamente* 'rightly'	
4. -Syn -Phon	*affidabile* 'reliable'	

Table 6.1: Experiment 6.1: design and sample stimuli.

To prevent strategic effects, we furthermore included 262 filler pairs, so that critical prime-target pairs made up only 16% of all items. Moreover, across primes and targets, there were 72 words that contained *-ment-*, constituting only 12% of the total. The total number of items thus amounted to 600 items, 50% of which were real words and 50% non-words. There were 18 filler adjectives and 18 filler adverbs not ending in *-mente* to ensure that the adjective and adverb primes were not the only adjectives and adverbs present in the experiment. The remaining fillers were equally split between nouns (both singular and plural) and verbs (infinitives and past participles). The majority of filler items were originally recorded for Experiment 5.1. Care was taken to ensure that fillers had variable syllable length.

Nonwords were created starting from real words, always keeping the first (few) syllable(s) intact and then changing one or more syllables starting from the end. ⅕ of all the nonwords differed from real words only for the last syllable. This meant that participants had to listen till the end of words to determine whether they were real words or not, hopefully ensuring that they were listening to the whole audiofile before making their lexical decision. The great majority of nonwords used in this experiment were the same as the ones used in Experiment 5.1 and resembled nouns or verbs, either infinitive or past participle verbs (see §5.4.1.1 for more details on the characteristics of the nonwords). The only difference was that all the non-words used in Experiment 5.1 that resembled words ending in *-zione* or *-ment-* were substituted with other nonwords for this experiment, in order to reduce conscious attention to these suffixes.

The stimuli were recorded by an adult female native speaker of Italian with a high-quality microphone (AKG C480b, capsule CK69 ULS), in a sound attenuated booth. Audiofiles were segmented using Praat (Boersma and Weenink 2015) and normalised to a peak amplitude of 70 dB SPL.

6.3.1.2 Participants

Using the online experiment platform Prolific, we recruited 120 participants (30 for each condition) that identified as native speakers of Italian living in Italy. They were paid 7.50$ for their participation in the experiment, which lasted approximately 30 minutes.

6.3.1.3 Procedure

The procedure was the same as in the previous experiments in this thesis, but it's repeated here for the sake of convenience. The experiment was conducted online using the Penn Controller for Internet Based Experiments (PCIbex) (Zehr and Schwarz, 2018). All stimuli were presented auditorily. A continuous lexical decision task was used, so that a response was provided to both primes and targets, as illustrated in Figure 6.1. The distinction between primes and targets was thus not made explicit to participants.

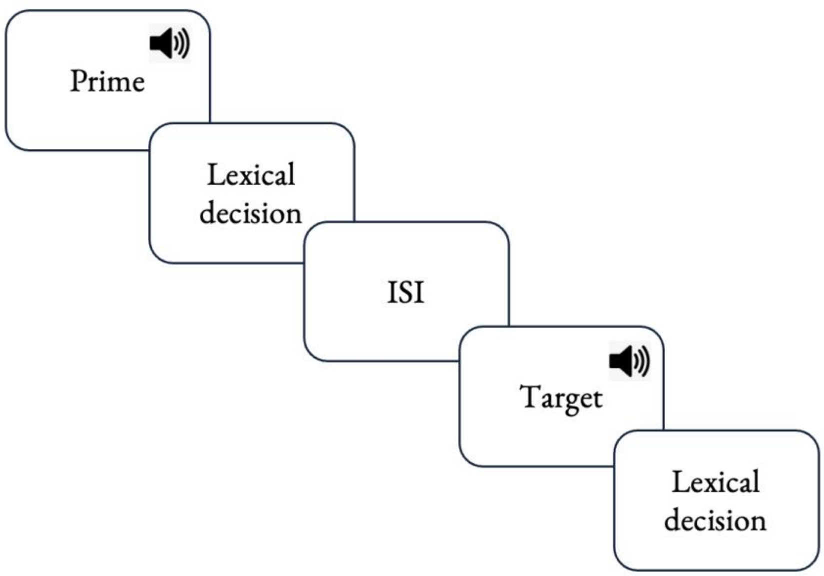

Figure 6.1: Continuous auditory lexical decision task.

The task had a random inter-stimulus interval between 400-600ms to prevent participants from responding rhythmically. The ISI was measured from the end of the sound file or participant response, whichever was later. Stimuli presentation was pseudo-randomised throughout the experiment for each participant such that critical prime target pairs occurred at the maximum possible distance from each other. The experiment consisted of 3 blocks with the possibility for a self-administered break after each block, and a practice trial of 24 items (50% of which were nonwords) at the beginning of the experiment in which participants were familiarised with the task and were provided feedback on each response. At the beginning of the experiment, participants were instructed that they would hear existing and non-existing Italian words, and that they had to make a lexical decision to each word as fast and as accurately as possible. Responses of 'word' and 'non-word' were recorded from keyboard (F and J) button presses. Participants were instructed to use headphones during the experiment.

6.3.2 Analysis

6.3.2.1 Data trimming

Mean accuracy by subject (as calculated on both critical and filler items) was extremely high (97.4%) and the participant with the lowest accuracy had an accuracy of 86.3%, so no participant was excluded on the basis of low accuracy. During the analysis phase, we realised that one of the primes in the +Syn -Phon, *documentazione* 'documentation', contained not only the suffix *-zion-* but also the suffix *-ment-*, and thus excluded it from further analyses, bringing the total data points to 5640 from the original 5760 (48 targets * 120 participants). Trials with incorrect responses to primes or targets were discarded, which led to an exclusion of 83 data points. All targets with outlier RTs (<500ms and >2500ms) were excluded, as well as the targets for which the prime had an outlier RT (<500ms and >2500ms). This led to a further exclusion of 95 data points. In total, the data trimming process led to the exclusion of 178 observations, or 3.16% of the total 5640 data points (after the exclusion of *documentazione*).

6.3.2.2 Modelling

The data were analysed as follows. Responses were coded for response type (word/non-word) and response time (RT; measured in ms from the onset of the sound file). RT data were then log10-transformed. We analysed effects on log10-transformed RTs (our dependent variable) with linear mixed-effects models, using the lme4 package (Bates et al. 2015, version 1.1-37) in the R environment (R Core Team 2024, version 4.5.0). We first fit a model that included a random slope for subject and a random intercept for target items. Since this model failed to converge, we fit a new model including random intercepts for subjects and target items. The following fixed effects were included in the model: Condition (+Syn+Phon condition, +Syn -Phon condition, -Synt +Phon condition and -Syn -Phon condition), Trial Number, Target Frequency, Target Duration and Prime RT. Trial Number and Target Frequency were chosen because they are generally known to influence Target RT. Target duration was inserted given the auditory nature of the experiment. Similarly, Prime RT was included because it was shown to have a direct impact on target RTs in similar experiments (Creemers et al., 2020, Gaston et al., 2021; Goodwin Davies and Embick, 2019, Loui et al., 2021; White et al., 2024). Condition was treatment coded with the -Syn -Phon condition as the reference level. Target Frequency, Target Duration and Prime RT are log10 transformed and z-scored, while Trial Number was z-scored. P-values are determined using the package lmerTest (Kuznetsova et al. 2016); significant p-values are reported at $p < 0.05$.

6.3.2.2 Results

An overview of the results is provided in Table 6.2 and in Figure 6.2. Table 6.2 gives the raw RT data, and Figure 6.2 illustrates the log-transformed RT data on which analyses were performed. Table 6.3 shows accuracy rates by experimental condition. Targets RTs in the +Syn+Phon and +Syn -Phon were respectively 30ms and 38ms faster than RTs in the -Syn -Phon condition. On the other hand, RTs in the -Synt +Phon were the same as RTs in the -Syn -Phon condition. The mixed-effect model of the log10-transformed RT data revealed significant facilitation ($p<0.001$) in both the +Syn+Phon condition and the +Syn -Phon condition, but not in the -Syn +Phon condition. Table 6.4 shows the model summary and reports the model formula (a best practice suggested by Meteyard and Davies [2020]).

Condition	**Target RT**	**Priming effect**
1. +Syn+Phon (*giuramento - allenamenti*)	1263ms (250)	-30ms
2. +Syn -Phon (*valutazione - allenamenti*)	1255ms (254)	-38ms
3. -Synt +Phon (*giustamente - allenamenti*)	1293ms (240)	0ms
4. -Syn -Phon (*affidabile - allenamenti*)	1293ms (242)	N/A

Table 6.2: Mean response times to the targets (in ms), priming effects (in ms). RTs are measured from the onset of the sound file. Priming effect is the RT for each condition minus the RT in the -Syn -Phon condition. Standard deviations are given in parentheses.

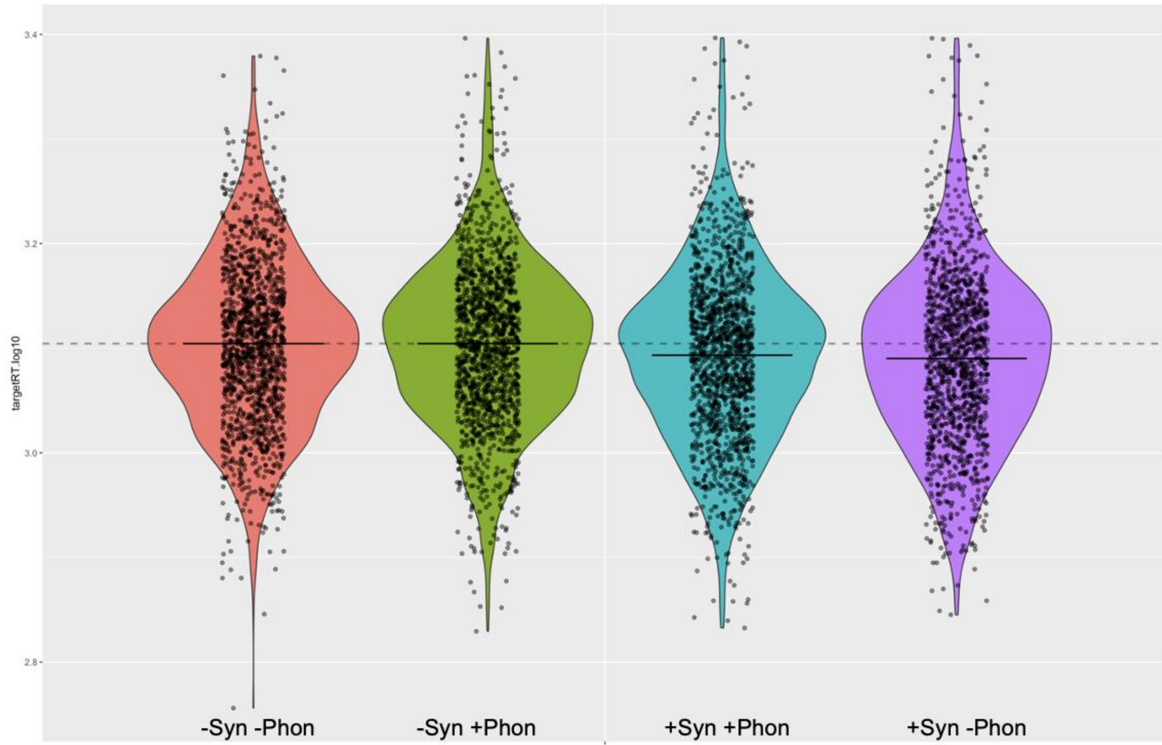

Figure 6.2: Violin plots of the log-transformed response times in Experiment 6.1 for all the experimental conditions. Black horizontal lines represent means by condition, dotted grey line represents the mean in the -Syn-Phon condition.

	% accuracy	
Condition	**Primes**	**Targets**
1. +Syn+Phon (*giuramento - allenamenti*)	99%	99.6%
2. +Syn -Phon (*valutazione - allenamenti*)	98.9%	99.6%
3. -Synt +Phon (*giustamente - allenamenti*)	99%	99.2%
4. -Synt -Ph (*affidabile - allenamenti*)	99.3%	99.4%

Table 6.3: Error rates (number of incorrect responses) to targets and primes per condition.

		Log10 transformed RTs	
Fixed effects	*Estimate (β)*	*CI*	*p-values*
Intercept	3.107	3.099 – 3.114	**<.001**
Prime type			
+Syn+Phon vs. -Syn-Phon	-0.0124	-0.017 – -0.008	**<.001**
+Syn-Phon vs. +Syn+Phon	-0.02	-0.024 – -0.015	**<.001**
-Syn+Phon vs. +Syn+Phon	-0.001	-0.006 – 0.003	0.526
Trial Number	-0.009	-0.012 – -0.007	**<.001**
Log10-transformed Target Frequency	-5.6E-04	-0.003 – -0.002	0.716
Log10-transformed Target Duration	0.029	0.026 – 0.032	**<.001**
Log10-transformed Prime RT	0.023	0.021 – 0.024	**<.001**
Random effects	*N*	*Variance*	*SD*
Subject	120	0.001	0.035
Targets	48	7.7E-05	0.009
Residual		0.003	0.057
N Datapoints			5462

Table 6.4: Experiment 6.1: Model summary. Model formula: targetRT.log10 ~ prime_type + zTrialNum + zLog10_targetfreq + zLog10TargDur + zLog10_PrimeRT + (1 | Subj) + (1 | target)

6.4 Discussion

In this experiment, we aimed to tease apart morphophonological priming from morphosyntactic priming. We did this by comparing three potential sources of priming. In the +Syn+Phon condition, prime and target were respectively a singular and a plural deverbal noun containing the suffix *-ment-*

(*giuramento* → *allenamenti*). Thus, they shared both morphosyntactic structure and the morphophonological realisation of that structure. In the +Syn-Ph condition, the prime was a singular deverbal noun containing a different suffix, namely *-zion-* (*valutazione* → *allenamenti*). In this case, prime and target shared morphosyntactic structure, but did not overlap phonologically. In the -Syn+Phon condition, primes were adverbs containing the suffix *-mente* which is accidentally homophonous with the nominal suffix *-ment-* but doesn't share any morphosyntactic structure with it (*giustamente* → *allenamenti*). Each of the three priming conditions was compared against an unrelated prime condition where primes were adjectives that did not share any morphosyntactic or morphophonological similarity with the target (*affidabile* → *allenamenti*).

We found a significant priming effect in the +Syn+Phon condition, where prime and target are morphosyntactically and morphophonologically similar (*giuramento* → *allenamenti*). We also found a substantial priming effect in the +Syn-Ph condition, where prime and target just share morphosyntactic structure (*valutazione* → *allenamenti*). However, we did not find any priming effect at all in the -Syn+Phon condition, where prime and target share four phonological segments, namely /-ment-/, but are morphosyntactically unrelated. While it is not unsurprising that we found a priming effect in the +Syn+Phon condition, to the best of our knowledge it is the first time that priming of a derivational affix is found auditorily. Indeed, the only other study of this kind that we are aware of, namely Emmorey (1989), did not find any difference in priming between words that had a pure phonological overlap (*tango* → *cargo*) and words that shared a derivational suffix (*shortness*→ *blackness*). However, the present results are in line with results in the visual modality, such as Duñabeitia et al. (2008) and Gaston et al. (2021), which do find priming of derivational suffixes.

There are two surprising results in this experiment. First of all, the amount of priming in the +Syn+Phon (*giuramento* → *allenamenti*) and the +Syn-Ph (*valutazione* → *allenamenti*) conditions is not qualitatively different despite the fact that in the first condition not only share morphosyntactic structure, but also phonological similarity. Secondly, we do not find any facilitation in the -Syn+Phon condition (*giustamente* → *allenamenti*). In other words, we do not find any facilitation for sharing phonological material. These results are in line with the results in Goodwin Davies and Embick (2019) and White (2021), where pure phonological overlap (respectively, *cleanse* → *trees* and *dolphin* → *talkin'*) does not lead to facilitation. The picture is not so clear-cut in White et al. (2024): phonological overlap between *ceiling* → *talking* engenders smaller (Exp. 3a) or non-significant priming (Exp. 3b) than *jumping* → *talking* where prime and target are not only phonologically similar, but also share morphosyntactic structure (they are both progressive verbs). Finally, the results in this experiment differ radically from Emmorey (1989), where the origin of priming seems to be clearly phonological. Indeed, in Exp. 2 and 3, Emmorey (1989) finds the same amount of priming (>60ms) for primes and targets that share the last syllable whether they share a suffix (*shortness*→ *blackness, dumping* → *shaping*) or not (*tango* → *cargo*). Emmorey (1989) also finds a statistically non-significant facilitation effect of less than 30ms when prime and target rhyme, whether they share a suffix (*smiling*→ *breaking* in Exp. 2 and 3) or nor (*baloon*→ *saloon* in Exp. 1).

There are two important differences between Emmorey (1989), and the present study. First of all, in Emmorey (1989) primes and targets minimally share a rhyme (engendering a non-significant facilitation) or otherwise share the whole of the last syllable (engendering a robust priming effect). Thus, it might be that what matters for phonological priming is not segment overlap, which we tried to maximise in this experiment, but sharing a rhyme or the full final syllable. This would also explain why Goodwin Davies and Embick (2019) pattern with the present experiment (primes and targets there share only the last segment), and why instead White et al. (2024) find at least some evidence for phonological priming (primes and targets rhyme in those experiments). The other difference between Emmorey (1989) and the present experiment is that here we used a continuous lexical decision task, in which participants responded not only to targets but also to primes. This could have influenced the results in two ways. First of all, the fact that the prime and target structure of the experiment is not made clear to participants may have reduced any conscious strategic response. Secondly, the fact that the prime is responded to might reduce the phonological effect of the prime onto the target. Notice that Goodwin Davies and Embick (2019), White (2021) and White et al. (2024) all use the same continuous lexical decision task as the one deployed here, and equally find no or very little phonological priming.

The lack of phonological facilitation in both the +Syn+Phon and in -Syn+Phon conditions clearly speaks in favour of a morphosyntactic origin of the priming. Indeed, we find robust priming in the +Syn-Ph condition, where prime and target are phonologically dissimilar but are both deverbal nouns (*valutazione* → *allenamenti*). As we have seen in section 6.1, *-zion-* and *-ment-* could be two different morphophonological realisations of the same morphosyntactic head or they could be realisations of two distinct morphosyntactic heads with the same function, namely turning a verb into a noun. Whatever the correct analysis of these facts is, in this experiment we identified a priming effect between nouns in *-zion-* and nouns in *-ment-*. What these nouns have in common is that they are derived from verbs. From this experiment, we can't know whether the priming we see here is purely priming of a nominalising head, that is category priming (a noun priming another noun) or if it is specifically priming of a nominalising head taking a verb as a complement (a deverbal noun priming another deverbal noun). This is because the other two primes in our experiment were an adverb and an adjective. The results from Experiment 4.1 on Hebrew did not show facilitation when primes and targets were both verbs as opposed to when they were a noun and a verb. This seems to suggest that what's causing the priming in this experiment is specifically the fact that primes and targets were deverbal nouns.

To the best of our knowledge, there is only one previous experiment investigating the effects of lexical category on priming, namely Vigliocco et al. (2007). In an overt visual priming paradigm (prime shown for 67ms), Vigliocco et al. (2007) show that verb targets are responded to faster when they are preceded by a verb rather than by a noun. However, this effect is found only when the prime verb co-occurs with the particle *to*, which makes verbs part of a syntactic phrase. The present results differ from Vigliocco et al.'s (2007) since in our experiment the prime is not part of a syntactic phrase. However, there are some important differences between the current experiment and Vigliocco et al. (2007) which could have led to these different results. First of all, the different modality (auditory vs visual); secondly, the fact that our experiment was a continuous lexical decision task where primes were not clearly identified as such, while that was not the case in Vigliocco et al. (2007), and thirdly, the fact that they're working with verbs instead of nouns. Thus, more work should be done to understand under what conditions lexical category priming can be obtained and whether priming can be sensitive to even subtler morphosyntactic similarity (e.g., priming of specifically a deverbal noun).

Summarising, the results of this experiment provide evidence that a lexical decision task using auditory priming is more sensitive to morphosyntactic structure than to phonological similarity. As we have seen, the results of this experiment are directly at odds with those in Emmorey (1989), who instead finds evidence for phonological priming. Thus, the present results lead us to reflect on how the characteristics of the experimental task, continuous lexical decision as opposed to a more traditional paired lexical decision, influence the priming effects we see. Moreover, the fact that we found priming between two deverbal nouns will need further investigation to determine if the effect we see is due to simply belonging to the same lexical category priming or whether it is due to priming of more fine-grained morphosyntactic structure. Regardless, the present results enlarge our understanding of priming and open up new experimental possibilities.

6.5 Conclusion

In this experiment, we saw that a significant facilitation is found when prime and target share morphosyntactic structure and its morphophonological realisation (*giuramento* → *allenamenti*), as well as when they only share morphosyntactic structure (*valutazione* → *allenamenti*). Instead, no facilitation is identified when prime and target only overlap phonologically (*giustamente* → *allenamenti*). When combined, these results suggest that in auditory, continuous lexical decision tasks priming is more sensitive to morphosyntactic structure than to phonological similarity, confirming what has been found in the inflectional domain by Goodwin Davies and Embick (2019), White (2021) and White et al. (2024). While additional evidence is needed to determine the impact of task characteristics on priming results, this experiment suggests that priming can be used to behaviourally detect morphosyntactic similarity in line with what already found in Experiment 4.2.

Chapter 7

Conclusions

7.1 Where we started

The aim of this dissertation was to reconcile the analytical literature with the psycholinguistic one. Indeed, in the analytical literature, the last 30 years have seen wide agreement on the necessity of abandoning the traditional notion of morphemes, and to instead distinguish between morphosyntactic objects, and their morphophonological realisations. This dissertation adopted this analytical consensus, and used mismatches between morphosyntax and morphophonology to determine whether priming is more sensitive to morphosyntactic organisation or phonological similarity. In a nutshell, the experiments conducted in this thesis provide initial, but compelling evidence that priming experiments using a continuous lexical decision task are finely attuned to morphosyntactic features rather than to (morpho)phonological similarity. Before discussing the consequences of these results, let us briefly review how each chapter unfolded.

7.2 Morphological consensus

Chapter 2 was dedicated first of all to highlighting the empirical shortcomings of traditional morphemes, showing how they are unable to account for the many mismatches between meaning, syntax and form that we find in the world's languages. The second part of that chapter reviewed a handful of current theories of morphology, namely A-morphous morphology, Distributed Morphology, Nanosyntax, Spanning and Non-isomorphism. The discussion of each of them and the comparison among them was meant to foreground their common traits, without playing down their differences. The picture that emerges is that, in the affixal domain, all these approaches to morphology agree in differentiating morphosyntactic features from their morphophonological realisations. In the lexical domain, A-morphous morphology postulates the existence of lexical items, which are sets of semantic and syntactic properties that can be associated with one or more multiple morphophonological forms (Anderson, 1992: 122). All the other approaches reviewed here adopt morphosyntactic roots which can have not only multiple morphophonological forms, but also different meanings in different contexts.[138] While this difference is quite substantial from an analytical point of view, it is unclear that it makes radically different predictions from a psycholinguistic one.[139] Indeed, at the relevant level of abstraction,

[138] This is not entirely accurate for Spanning, where there is no mention of meanings of morphosyntactic objects.
[139] As we have seen in Chapter 2, the biggest difference in predictions is probably regarding words that are viewed as derived from the same root in syntactic approaches to morphology, but that would instead be considered as different lexical items in

what all the approaches of morphology reviewed in Chapter 2 have in common is that they distinguish, both in the affixal and in the lexical domain, between morphosyntactic objects and morphophonological realisations.

7.3 Re-evaluating previous experimental evidence

Chapter 3 was a re-evaluation of previous experimental evidence in view of the analytical developments seen in Chapter 2. The basic question of the chapter can be stated as follows: if there are no morphemes, how are we supposed to make sense of 'morphological' priming effects? The answer is that so-called morphological effects could be due to any of the components of morphemes: their morphosyntax, their meaning, or their morphophonology. While ruling out a semantic origin of morphological priming has been attempted in the literature before and has proven to be relatively easy, very few studies have attempted to disentangle morphosyntax from morphophonology. Thus, the existing experimental evidence did not generally allow us to adjudicate between a morphosyntactic and a morphophonological origin of 'morphological' priming effects. This is true both for root priming effects, which are widely replicated in the literature, and for affix priming effects, which instead have proven are more difficult to identify experimentally.

Chapter 3 also called for a re-thinking of how comprehension and lexical decision unfold if we abandon traditional morphemes. This requires moving away from a view of comprehension as

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A-morphous morphology. An example of this would be the adjective *lovable*, which in syntactic approaches to morphology has the same syntactic root of *love*. In A-morphous morphology, instead, *lovable* is derived from *love* via a Derivational Word Formation rule, and thus constitutes its own independent lexical item.

‘morpheme spotting’, where the goal is identify morpheme boundaries, and then conjoin their meanings to get to the meaning of the whole word. Instead, comprehension is an inference problem where the aim is to get at the correct meaning by postulating the appropriate morphosyntactic structure from the surface phonological form. This revised understanding of how comprehension works, as well as questions on whether word boundaries are strictly needed for auditory comprehension, should guide new experiments in the field, to determine how processing unfolds if we give up the assumption or traditional morphemes, and question the notion of traditional words as well.

In Chapter 3, we also looked briefly at modality issues. Indeed, the majority of priming experiments are carried out in the visual modality, and thus involve orthographic representations. In more recent works and in this thesis, experiments use auditory stimuli instead. This is, first of all, because the visual and the auditory modality are very different presentationally. In the visual modality, a whole word can be processed at once. On the other hand, in the auditory modality, the processing of stimuli is incremental and unfolds over time. Given these differences, it is highly probable that the processing mechanisms involved in the two are different.[140] Thus, if we want to better understand how processing of speech works, we should move away from using visual paradigms and instead deploy auditory stimuli. Moreover, while orthographic and phonological representations are surely interrelated, it is unclear exactly how. Thus, using auditory stimuli allows us to get more directly at phonological and morphophonological representations without the mediation of orthographic ones. Summarising,

[140] Another key difference between speech/sign comprehension and reading is that in reading orthographic word boundaries are clearly signalled. This is one more reason to think that speech/sign comprehension and reading work differently, even if one still assumes words in their theory. That’s because in speech/sign comprehension word boundaries would need to be identified first, while they are ‘given’ in reading.

Chapter 3 highlighted the importance of using an auditory paradigm, as well as the fact that existing studies were generally unable to adjudicate between a morphosyntactic and morphophonological origin of 'morphological' priming effects.

7.4 Priming morphosyntactic features

The experimental part of the dissertation started in earnest in Chapter 4, where we used a corner of Hebrew morphology to disambiguate between priming of morphosyntax and morphophonology. In Hebrew, person and agreement affixes differ in the past and future tenses. More specifically, we looked at the different realisations of first person plural. In the past tense, first person plural is realised as the suffix *-nu*, while in the future tense it is realised as the prefix *n-*. Thus, we wanted to test if two different morphophonological realisations of the same morphosyntactic features could prime each other.

In Expertiment 4.2, we tested this with a very simple experimental design. The targets were first person plural verbs in the future tense. Primes in the +Person +Number condition were first person plural verbs in the past tense. We compared this condition to an Unrelated condition where the prime was a second person singular masculine verb in the past tense.

Condition	**Prime**	**Target**
1. +Pers +Num	*balatnu* 'we stood out'	*nirkoʃ* ' 'we will buy'
2. Unrelated	*galaʃta* 'you.sing.masc surfed'	

Table 7.1: Experiment 4.2: design and sample stimuli.

In this experiment, we found a statistically significant difference between the +Person +Number condition and the Unrelated one, as shown in Table 7.2. In other words, we showed that two different morphophonological realisations of the same morphosyntactic features could prime each other. These results provide initial evidence that priming is more sensitive to morphosyntactic features than to morphophonological realisations.

Condition	**RT target**	**Priming effect**
1. +Pers +Num (*balatnu - nirkoʃ*)	1102 ms (208.4171)	-23ms
2. Unrelated (*galaʃta - nirko□*)	1125 ms (217.0069)	N/A

Table 7.2: Mean response times to the targets (in ms), priming effects (in ms). RTs are measured from the onset of the sound file. Priming effect is the RT for each condition minus the RT in the unrelated condition. Standard deviations are given in parentheses.

7.5 Priming morphosyntactic roots

In Chapter 5, we looked at allomorphy in the domain of roots. Indeed, in Italian, there are some roots whose morphophonological realisation is different in the past participle than in other tenses. For instance, the same syntactic root can be spelled out as *mett-* in the infinitive (*mett-ere* 'to put') and as *mess-* in the past participle (*mess-o*, 'put, masculine past participle'). The other interesting fact about these verbs is that they can be combined with different prefixal prepositions, and thus acquire different meanings. For instance, *pro-mett-ere* means 'to promise' and *tra-smett-ere* 'to transmit', even if they are both derivative of *mett-ere* 'to put'. The fact that these roots are realised in different ways morphophonologically and can have different meanings made them the perfect test ground to isolate syntactic roots from their meanings and their realisations, and to determine exactly what aspect of the representation engenders priming.

The targets in this experiment were irregular past participles of complex verbs, i.e., verbs that were made up of a prefix and an irregular form of the root. We had three different priming conditions. In the root and prefix condition, the prime was the infinitive form of the target, thus it shared the prefix, the root and the meaning with the target, but had a different morphophonological realisation of the root. In the root only condition instead, the prime was the infinitive form containing the same root as the target, but having a different prefix and thus a different meaning. In the unrelated condition, the prime was a complex verb with a different verb and different prefix. Table 7.3 summarises the conditions.

Condition	**Prime**	**Target**	**Root**
1. Root and prefix	*pro-mett-ere*	*pro-mess-o* 'promised'	*mett/mess*
2. Root only	*tras-mett-ere* 'to transmit, pass down'		
3. Unrelated	*con-fid-are* 'to confide, trust'		

Table 7.3: Experiment 5.1: design and sample stimuli.

Table 7.4 shows the results of the experiment. As expected, we obtained a large amount of priming in the root and prefix condition, since primes and targets in this condition share the morphosyntactic root, the prefix and their meaning. On the other hand, the difference between the Root only condition and the unrelated one amounted numerically to 14ms, but was not statistically significant. In other words, the difference between the root only condition and the unrelated one could either be due to random variance, or it could be due to the morphosyntactic priming effect being too small to be reliably identified with this number of participants. Either way, the results in this experiment are different from the ones in Experiment 4.2 and Experiment 6.1, where we see a much larger priming effect (23ms and ≥30ms respectively) for shared morphosyntactic representations. In section 7.7 we discuss the possible reasons behind this.

Condition	Target RT	Priming effect
1. Root and prefix (*promettere - promesso*)	1371ms (251)	-81ms
2. Root only (*trasmettere - promesso*)	1438ms (252)	-14ms
3. Unrelated (*confidare - promesso*)	1452ms (247)	N/A

Table 7.4: Mean response times to the targets (in ms), priming effects (in ms). RTs are measured from the onset of the sound file. Priming effect is the RT for the unrelated condition minus the RT for each condition. Standard deviations are given in parentheses.

7.6 Priming of derivational affixes

In chapter 6, we approached the question of what representation priming is more sensitive to from the opposite perspective than the one adopted in Chapters 4 and 5. Instead of using cases where the same morphosyntactic feature(s) or root was spelled out differently in different contexts, we resorted to a case of accidental homophony between two derivational affixes, where two affixes are very similar phonologically, but they do not share any morphosyntactic features. More specifically, in Italian, the nominalising head spelled out as /-ment-/ is phonologically very similar to an adverbialising head spelled out as /-mente/. This is a mere accident, but it provides another mismatch between morphophonology and morphosyntax that we can use to test the origin of priming effects. The targets in this experiment were plural nouns containing the suffix *-ment-*. In the +Syn+Phon condition, the prime was a singular noun containing the same suffix *-ment-* as the target. In the +Syn -Phon condition, the prime was a singular deverbal noun, just like in the +Syn -Phon, but it contained a different suffix, namely *-zion-*. In the -Synt +Phon condition, the prime was an adverb containing the suffix *-mente*. In this condition, prime and target have the same amount of phonological overlap as in the first condition, but they are morphosyntactically unrelated, allowing us to tease apart the contributions of morphosyntax and morphophonology. Finally, in the -Syn -Phon, the prime is an adjective unrelated to the target.

Condition	**Prime**	**Target**
1. +Syn+Phon	*giuramento* 'oath'	*allenamenti* 'trainings'
2. +Syn -Phon	*valutazione* 'evaluation'	
3. -Synt +Phon	*giustamente* 'rightly'	
4. -Syn -Phon	*affidabile* 'reliable'	

Table 7.5: Experiment 6.1: design and sample stimuli.

The results showed a clear priming effect in conditions 1 and 2, where prime and target are both deverbal nouns, but none at all in the -Synt +Ph condition where prime and target are phonologically very similar, as shown in Table 7.5. Moreover, the amount of priming was similar in the +Syn+Phon and the +Syn -Phon conditions, showing no advantage for sharing the morphophonological realisation of the nominalising head. This double lack of phonological priming in both the +Syn+Phon and the -Synt +Phon conditions provides strong evidence that the priming effect was driven by morphosyntactic similarity only. These effects are in line with previous results in Goodwin Davies and Embick (2019), where two plural nouns (*crimes* → *trees*) primed each other but pure phonological overlap (*cleanse* → *trees*) does not lead to facilitation. The morphosyntactic similarity in the current context could be the fact that primes and targets in the +Syn+Phon and the +Syn -Phon conditions are both nouns, or even more specifically, by the fact that they are both deverbal nouns. Further experiments are needed to adjudicate between these two possibilities.

Condition	**Target RT**	**Priming effect**
1. +Syn+Phon (*giuramento - allenamenti*)	1263ms (250)	30ms
2. +Syn -Phon (*valutazione - allenamenti*)	1255ms (254)	38ms
3. -Synt +Phon (*giustamente - allenamenti*)	1293ms (240)	0ms
4. -Syn -Phon (*affidabile - allenamenti*)	1293ms (242)	N/A

Table 7.6: Mean response times to the targets (in ms), priming effects (in ms). RTs are measured from the onset of the sound file. Priming effect is the RT for the -Syn -Phon condition minus the RT for each condition. Standard deviations are given in parentheses.

7.7 General discussion

7.7.1 The results in this dissertation

This dissertation is the first to systematically attempt to disentangle morphosyntax from morphophonology experimentally. Experiments 4.2 and 6.1 clearly show that priming effects are driven by morphosyntax, rather than by phonological similarity. In Experiment 4.2 we find priming across different morphophonological realisations of the same syntactic features in Hebrew. In Experiment 6.1, instead, we observe that deverbal nouns prime each other despite having different suffixes. As we have seen in the previous sections, Experiments 4.2 and 6.1 show that priming effects are driven directly by morphosyntax, similarly to what was found in Goodwin Davies and Embick (2019). On the other hand, Experiment 5.1 was inconclusive in this respect, since the numerical difference (14ms) between the root only condition (*trasmettere* → *promesso*) and the unrelated condition (*confidare* → *promesso*) is not statistically significant.

7.7.2 Comparison with previous results

7.7.2.1 Experiment 5.1

As we have seen in Chapter 3, while root priming has been widely investigated in the priming literature, previous results cannot adjudicate between a morphosyntactic and a morphophonological origin of the priming in those experiments. Experiment 5.1 was meant to address precisely this question, but they did not provide unambiguous evidence for morphosyntactic priming. One possible reason for this is that the verbs used in Experiment 5.1 are not actually morphosyntactically complex. In other words, these verbs might be not be analysed by modern speakers into a preposition and root, and might instead be represented as having a root that is spelled out as /promet:/ and /promess:/. If that's the case then, the lack of morphosyntactic priming is not surprising, because in that case *trasmettere ~ promesso* would not have a morphosyntactic root in common. Moreover, the small priming effect could potentially be due to individual differences in the representation of these verbs, meaning that some speakers represent these verbs as being made up a preposition (spelled out as /pro/) and a root (spelled out as /met:/ or /mes:/), and others instead represent it only as a root (spelled out /promet:/ or as /promes:/).

Further experiments are needed to clarify the cause of priming in condition 1 in Experiment 5.1 (*promettere - promesso*), where primes and targets share a root, a prefix and a meaning. For instance, the impact of meaning on our experimental results could be teased apart by designing a condition in which prime and target share the same root allomorph, but have different prefixes and therefore different meanings (*trasmettere* → *promettendo*). This would provide us with a direct comparison with previous studies on Dutch, Hebrew and Arabic where words sharing the same root but having different meanings prime each other (Boudelaa and Marslen-Wilson 2000, 2004, 2005, 2015; Creemers et al., 2020; Frost et al., 1997, 2000; Deutsch et al., 1998; Geary and Ussishkin 2019).

As far as form priming is concerned we find different results in different modalities. In the visual modality, the same amount of priming is found when primes and targets actually share a root (*cleaner* → *clean*) as well as in an orthographic control condition (*corner* → *corn*) where the prime could in theory be analysed as containing the target (*corn*) and an affix (*-er*). Both of these are much bigger than another orthographic control (*brothel* → *broth*) where the prime orthographically contains the prime, but the remaining orthographic piece (*-el*) is not an affix in the language (see e.g., Rastle et al., 2004 among others). These results are usually interpreted as evidence for aggressive affix stripping (Taft and Forster, 1975). However, as we have seen above, it is unclear that this results allow to disambiguate between a morphophonological and morphosyntactic origin of priming.

In the auditory modality, Emmorey (1989, Exp. 1) finds a reliable priming effect only between primes and targets that share a root (*submit*→*permit*), but not between primes and targets that share the last syllable (*balloon*→*saloon*). These results seem to suggest that form similarity is not enough to engender priming in auditory priming. Moreover, these effects are especially interesting because in the affixal domain, Emmorey (1989, Exp. 2 and 3) finds the same amount of priming between primes and targets that share an affix (*shortness*→ *blackness*), and words that just had the last syllable in common (*tango* → *cargo*).

The results in Experiment 5.1 are not directly comparable to the ones in Emmorey (1989, Exp. 1) since in our experiment primes and targets had different morphophonological forms (*trasmettere - promesso*). Further studies should determine if there is a priming effect between two different verbs that nevertheless share the same form of the root but do not rhyme with each other (*trasmettere* → *promettendo*). The present results also differ from Rastle et al. (2004) since in that experiment the focus was on form similarity, and not on sharing a morphosyntactic root. Since, as we have seen, the results in Experiment 5.1 could be due to irregular verbs in Italian not being morphosyntactically complex (at least for some speakers), it is difficult to judge whether they show evidence that morphophonological similarity is more important than morphosyntactic similarity in the lexical domain. Further research should address this question.

7.7.2.1 Experiments 4.2 and 6.1

Despite the inconclusive results in Experiment 5.1, the results in Experiment 4.2 and 6.1 clearly show that priming is sensitive to morphosyntactic similarity rather than (morpho)phonological similarity. This is shown both by the fact that different morphophonological realisations of the same bundle of morphosyntactic features prime each other (Experiment 4.2) as well as from the lack of phonological and morphophonological priming in Experiment 6.1. Let us review them in turn.

Only two existing experiments, namely Smolík (2010) ad White et al. (2014), had a similar design as to Experiment 4.2. The pattern of results in Smolík (2010), which attempted to determine priming effects of allomorphs of nominative case in Czech, is quite complex, making a comparison between Experiment 4.2 and Smolík (2010) difficult. On the other hand, White et al. (2024) showed priming between the allomorphs *-ing* and *-in'*, but there is debate in the analytical literature on whether these are suppletive allomorphs of each other, or whether *-in'* is derived from *-ing* phonologically. Thus, it is unclear whether these experiments are getting only at a shared morphosyntactic representation, or at shared representations both in morphosyntax and morphophonology. In other words, Experiment 4.2 is, to the best of our knowledge, the first experiment to show unambiguously priming between suppletive allomorphs.

In Experiment 6.1, we found a double lack of phonological facilitation. Indeed, we did not find any priming effect between prime and targets that shared 4 phonological segments but no morphosyntactic structure (*giustamente* 'justly' → *allenamenti* 'trainings'). Moreover, the amount of priming was the same when primes shared a suffix (*giuramento* 'oath' → *allenamenti* 'trainings') as when they only shared morphosyntactic structure (*valutazione* 'evaluation' → *allenamenti* 'trainings'). Two existing visual experiments, namely Chateau et al. (2002) and Dominguez et al. (2010) attempted to get at the same question.

Chateau et al. (2002) investigated the difference between what they call 'high consistency' prefixes (i.e., prefixes that rarely occur as pseudoprefixes, e.g., *un* in *unable* vs *uncle*) and 'low consistency' prefixes (i.e., prefixes that rarely occur as pseudoprefixes, e.g., *de* in *decode* vs *desert*). In Experiment 1, Chateau et al. (2002) found statistically significant priming between primes and targets containing high consistency prefixes (*unable*→ *unfair*) and low consistency prefixes (*degrade* → *decode*). However, the amount of priming was numerically not very different from the one found in an orthographic control. Moreover, in Experiment 2, Chateau et al. (2002) tested the effect of pseudo-affixed primes on prefixed targets containing high consistency prefixes (*uncle* → *unable*) or low consistency prefixes (*decay* → *devalue*), and found a priming effect only in the high consistency condition. Similarly to the data in Rastle et al. (2004), this pattern of results seems to suggest that affix priming is due more to orthographic overlap than to a shared prefix but only when the affix is reliably identifiable as such. On the other hand, Dominguez et al. (2010), working on Spanish prefixes, find that affix priming (*infelix* 'unhappy' → *incapaz* 'incapable') is the same as purely orthographic priming at short SOAs (*infelix* 'unhappy' →

insulto 'insult'), while, at long SOAs, affixed words had facilitatory effects and pseudo-affixed words had inhibitory ones instead. Thus, the results on affix priming coming from the visual modality are not conclusive as to whether what's driving the priming effect is sharing an affix or just orthographic overlap. Once more then, the results in Experiment 6.1 are, to the best of our knowledge, the strongest evidence that priming is sensitive to morphosyntax rather than it is to phonological and morphophonological similarity. In section 7.7.4, we investigate how modality and task might have resulted in differences in the experimental results.

7.7.3 On other possible sources of priming

As we have seen in Chapter 3, there are, in general, three possible causes of priming: a shared morphosyntactic object, its meaning or its morphophonological realisation. The aim of this dissertation has been to try and disentangle a morphosyntactic and a morphophonological origin of priming. The question then arises as to whether the meaning of the morphosyntactic objects involved could have been the cause of the priming, rather than the morphosyntactic objects themselves. Let us review each experiment in turn to see if that could have been the case. As we have seen, Experiment 4.2 is, to the best of our knowledge, the first experiment to show priming of two suppletive allomorphs. Thus, it is also the first experiment to identify priming of morphosyntactic features. For this experiment then, it is impossible to directly rule out that it wasn't the meaning of first person plural rather than the morphosyntactic feature itself to engender priming. Going forward, one possible way to rule out a semantic origin of the priming is to deploy specific cases where the meaning of morphosyntactic features doesn't correspond to the 'usual' meaning of those features. However, as a matter of fact, this will be difficult to do with inflectional morphosyntactic features, since these tend to have stable meanings, while being realised by different morphophonological forms.

As we have seen above, in Experiment 5.1, it is very difficult to determine how much of the priming effect in Condition 1 (*promettere* 'promise'- *promesso* 'promised') is due to meaning or to phonological overlap. In Chapter 5, I suggested a few ways to deal to try and disentangle these two possibilities. If meaning were the cause of priming in this experiment, this would differ from the cases of root priming in the literature, where in many languages we find root priming independently of meaning (Boudelaa and Marslen-Wilson 2000, 2004, 2005, 2015; Creemers et al., 2020; Frost et al., 1997, 2000; Deutsch et al., 1998; Geary and Ussishkin 2019). However, as we have seen, the interpretation of the results in Experiment 5.1 is complicated by whether or not verbs like *promettere* 'promise' are analysed as complex by all speakers of Italian or not. As already noted in Chapter 5, further investigation into this is needed to be able to draw wider conclusion about root priming in Italian.

In Experiment 6.1, we identify priming between singular and plural nouns in *-mento* (*giuramento* 'oath' → *allenamenti* 'trainings') as well between *-mento* and *-zione* nouns (*valutazione* 'evaluation' → *allenamenti* 'trainings'). We interpreted these results as being due to the fact that both affixes are the morphophonological realisations of morphosyntactic heads that turn a verb into a noun. There are multiple interpretations for these morphosyntactic heads, with at least an event reading and a result meaning available for the majority of them (see Grimshaw 1990, Borer 2013, Benz 2025 among many others). Given that in a lexical decision task it is impossible to know which interpretation of each noun participants access (or whether they have to access a specific interpretation at all), it is very difficult to determine how much of a role meaning played in this priming effect. However, precisely the presence of various possible interpretations of these morphosyntactic heads makes it more plausible that it is syntax rather than meaning that is driving the priming effect.

7.7.4 On modality and task

The results in this dissertation show that priming can be extremely effective in detecting morphosyntactic similarity, above and beyond (morpho)phonological similarity. The majority of previous experiments do not allow us to distinguish between a morphosyntactic and morphophonological origin of the priming, and even the experiments that were designed to get at similar questions do not always offer unambiguous results, especially across different modalities and experimental designs. We argue then that specific modality (auditory) as well as the specific experimental task (continuous lexical decision) deployed in this dissertation might have made morphosyntactic similarity come to the fore more prominently.

Indeed, as we have seen in Chapter 3, there are temporal differences between stimuli presented in the visual and in the auditory modality. While visual stimuli can be processed holistically (combining information from both ends of the written word), auditory stimuli are necessarily processed from left to right, and incrementally over time. In the visual modality then, there might be a greater bias towards identifying pieces of form than there is in the auditory modality. Moreover, the structure of the task, with its requirement to provide a response not only to targets but also to primes, reduces as much as possible any conscious attention to similarities between the two. Reduced conscious awareness is also favoured by the characteristics of the stimulus list: in all the experiments presented here, the amount of related stimuli was extremely reduced and never above 12% of the total stimuli. In previous studies instead, the percentage of related stimuli can be quite high, possibly tuning in participants on orthographic and phonological similarities. We suggest that the use of a continuous lexical decision task and of auditory modality may be the best available techniques to get at morphosyntactic similarity (as confirmed by similar effects found in Goodwin Davies and Embick [2019]). Under the right conditions, then, morphosyntactic priming can be quite similar to structural priming found at the sentence level (see Pickering and Ferreira, 2008).

It is important to highlight, however, that some forms of phonological priming are attested in continuous lexical decision in the auditory modality, most prominently rhyme prime (see Dufour, 2008 and Bacovcin et al., 2017 among others). Thus, interesting questions arise about under what conditions phonological priming can be identified in the auditory modality. Indeed, the results in Experiment 6.1 show that no phonological priming is identified even in the presence of quite a big phonological overlap (sharing the four segments of *-ment-*). Future experiments should address this question, for instance by determining whether sharing one or more initial syllables engenders phonological priming. This is one of the future directions that we explore in the next section.

7.8 Future directions

This dissertation showed initial but compelling evidence that priming can be used to identify morphosyntactic similarity. The present results also open further questions, which we review in turn.

The first question raised by the results in this dissertation is why we did not find definitive evidence for morphosyntactic priming in Experiment 6.1. In Chapter 6, we reviewed possible experiments that could give us a better understanding of what's causing priming in Condition 1 where prime and target have different morphophonological realisations of the same root, but share the same prefix and the same meaning (*promettere* 'promise'- *promesso* 'promised'). The contribution of meaning could be assessed by determining how much priming effect there is between verbs that share the same allomorph of the root but have different prefixes and, thus, different meanings (*trasmettere* → *promettendo*).[141] Another experimental manipulation would be to test priming between two different allomorphic forms of the same unprefixed verb in order to reduce the amount of phonological overlap between the two forms (*mettere* → *messo*). Having answers to these questions would help us to better understand what's driving priming in Experiment 6.1, and how this compares to existing experiments on root priming (most prominently Boudelaa and Marslen Wilson, 2004 and Creemers et al., 2020).

The second question that this dissertation opens up is about the conditions that lead to phonological priming. While a continuous lexical decision task that uses auditory stimuli and a high

[141] Using the present participle form *promettendo* instead of the infinitive *promettere* would rule out any potential rhyme prime effect.

number of filler items most probably reduces the chance of phonological priming, rhyme prime is still attested in similar experiments. Thus, future experiments should determine under what conditions does any kind of phonological priming arises, and in particular whether it arises in the presence of initial syllable(s) overlap.

Moreover, future experiments should try and disentangle a possible semantic origin of priming from a morphosyntactic one. While this was done repeatedly among roots (Boudelaa and Marslen-Wilson 2000, 2004, 2005, 2015; Creemers et al., 2020; Frost et al., 1997, 2000; Deutsch et al., 1998; Geary and Ussishkin 2019), it might prove more difficult to do in the affixal domain, especially among inflectional affixes.

At a higher level, the results in this dissertation also show that we can use experimental evidence to address analytical questions. For instance, in the presence of two conflicting morphosyntactic analyses of the same form, evidence from priming experiments could help us adjudicate this question.

As far processing goes, doing away with traditional morphemes require us to also abandon a view of comprehension as ‘morpheme spotting’. Moreover, some of the theories reviewed in Chapter 2 also move away from a traditional view of words. Future experiments that test how language comprehension unfolds over time without assuming morpheme or word boundaries should be conducted to determine what (if any) is the role of word boundaries in spoken/signed comprehension, and how it is that speakers/signers go from morphophonological forms to underlying morphosyntactic structures. In this regard, cases where multiple morphosyntactic parses of the same morphophonological sequence are available until a certain point in a sentence could be used to better understand how comprehension unfolds over time.

Finally, repeating some of the experiments done in this dissertation or similar ones using EEG and MEG could help us shed more light on how comprehension unfolds over time in the brain.

7.9 Conclusion

This dissertation aimed at bringing recent developments in analytical morphology to bear on psycholinguistic experiments. In current theories of morphology, there is general agreement that we need to distinguish between morphosyntactic objects and their morphophonological realisations. We addressed this question experimentally by looking at mismatches between morphosyntax and morphophonology in two languages, namely Hebrew and Italian. In Experiments 4.2 and 6.1, we found evidence that it is morphosyntax to engender priming effects. Instead, in Experiment 5.1, we did not identify a statistically significant morphosyntactic cause for priming. However, the results in this dissertation provide clear evidence that priming can be sensitive to morphosyntactic representations, as already found in Goodwin Davies and Embick (2019). While further experimental data are surely needed, the present work shows that it is possible to detect morphosyntactic representations using continuous lexical decision tasks and auditory priming. This opens new questions on the similarity between morphosyntactic and structural priming, the possibility to use experimental evidence to bear on formal questions and how we should re-think spoken/signed comprehension as it unfolds over time.

Appendix A - Critical stimuli for Experiment 4.1

	+Pers +Num	-Pers +Num	Unrelated	Target
1.	חידשנו *xidashnu* 'we renewed'	טחנו *taxnu* 'they grinded'	תזמורת *tizmoret* 'orchestra'	נסבול *nisbol* 'we will endure'
2.	בלטנו *balatnu* 'we stood out'	טיגנו *tignu* 'they fried'	מברשת *mivreshet* 'brush'	נקפוץ *niqfotz* 'we will jump'
3.	קדמנו *kadamnu* 'we preceded'	מיגנו *mignu* 'they procteted'	תוספת *tosefet* 'extension'	נכלול *nixlol* 'we will include'
4.	שיחקנו *sixaknu* 'we played'	קרנו *karnu* 'they beamed'	מחברת *maxberet* 'notebook'	נבגוד *nivgod* 'we will check'
5.	כשלנו *kashalnu* 'we failed'	רכנו *raxnu* 'they leaned/stooped'	משטרה *mishtara* 'police'	נמזוג *nimzog* 'we will pour out'
6.	גידלנו *gidalnu* 'we grew/cultivated'	שכנו *shaxnu* 'they resided'	תוצאה *totzaa* 'result, outcome'	נשרוט *nisrot* 'we will scratch'
7.	מתחנו *mataxnu* 'we stretched'	נתנו *natnu* 'they gave'	התחלה *hatxala* 'start, beginning'	נספור *nispor* 'we will count'
8.	לימדנו *limadnu* 'we taught/trained'	סימנו *simnu* 'they marked'	הדגמה *hadgama* 'illustration'	נשבות *nishbot* 'we will strike'
9.	פחדנו *paxadnu* 'we feared'	סיכנו *sixnu* 'they risked/endangered'	תופעה *tofaa* 'phenomenon'	נסגור *nisgor* 'we will close'
10.	בחרנו *baxarnu* 'we chose/elected'	רטנו *ratnu* 'they muttered/grumbled'	מרפסת *mirpeset* 'porch'	נמשוך *nimshox* 'we will pull'
11.	זכרנו *zaxarnu* 'we remembered'	בחנו *baxnu* 'they tested'	הבהרה *havhara* 'clarification'	נסתום *nistom* 'we will stop/block'
12.	פיתחנו *pitaxnu* 'we developed'	זימנו *zimnu* 'they convened'	העלמות *healmut* 'disappearance'	נמסור *nimsor* 'we will deliver/hand over'

13.	מתחנו *mataxnu* 'we stretched'	מיגנו *mignu* 'they procteted'	תוצאה *totzaa* 'result, outcome'	נשבור *nishbor* 'we will break'
14.	כשלנו *kashalnu* 'we failed'	סיכנו *sixnu* 'they risked/endangered'	תופעה *tofaa* 'phenomenon'	נגנוב *nignov* 'we will steal'
15.	שיחקנו *sixaknu* 'we played'	טחנו *taxnu* 'they grinded'	תוספת *tosefet* 'extension'	נדרוש *nidrosh* 'we will require'
16.	בחרנו *baxarnu* 'we chose/elected'	קרנו *karnu* 'they beamed'	הדגמה *hadgama* 'illustration'	נפשוט *nifshot* 'we take off (clothes)'
17.	קדמנו *kadamnu* 'we preceded'	רטנו *ratnu* 'they muttered/grumbled'	משטרה *mishtara* 'police'	נכפול *nixpol* 'we will multiply'
18.	לימדנו *limadnu* 'we taught/trained'	שכנו *shaxnu* 'they resided'	התחלה *hatxala* 'start, beginning'	נצפור *nitzfor* 'we will honk'
19.	חידשנו *xidashnu* 'we renewed'	סימנו *simnu* 'they marked'	הבהרה *havhara* 'clarification'	נפלוט *niflot* 'we will emit'
20.	בלטנו *balatnu* 'we stood out'	נתנו *natnu* 'they gave'	מרפסת *mirpeset* 'porch'	נבדוק *nivdok* 'we will betray/cheat'
21.	פחדנו *paxadnu* 'we feared'	רכנו *raxnu* 'they leaned/stooped'	מחברת *maxberet* 'notebook'	נפסול *nifsol* 'we will disqualify'
22.	גידלנו *gidalnu* 'we grew/cultivated'	טיגנו *tignu* 'they fried'	תזמורת *tizmoret* 'orchestra'	נכרוך *nikrox* 'we will bind (books)'
23.	זכרנו *zaxarnu* 'we remembered'	בחנו *baxnu* 'they tested'	מברשת *mivreshet* 'brush'	ננדוד *nindod* 'we will wander'
24.	פיתחנו *pitaxnu* 'we developed'	זימנו *zimnu* 'they convened'	העלמות *healmut* 'disappearance'	נמכור *nimkor* 'we will sell'
25.	חידשנו *xidashnu* 'we renewed'	מיגנו *mignu* 'they procteted'	משטרה *mishtara* 'police'	נצלול *nitzlol* 'we will dive'
26.	כשלנו *kashalnu* 'we failed'	סיכנו	תוצאה *totzaa* 'result, outcome'	נגמור *nigmor* 'we will finish'

		sixnu ‘they risked/endangered’		
27.	פיתחנו *pitaxnu* ‘we developed’	טחנו *taxnu* ‘they grinded’	תוספת *tosefet* ‘extension’	נצרוב *nitzrov* ‘we will scorch’
28.	בלטנו *balatnu* ‘we stood out’	נתנו *natnu* ‘they gave’	העלמות *healmut* ‘disappearance’	נרכוש *nirkosh* ‘we will buy’
29.	קדמנו *kadamnu* ‘we preceded’	בחנו *baxnu* ‘they tested’	תזמורת *tizmoret* ‘orchestra’	נפגוש *nifgosh* ‘we will meet’
30.	בחרנו *baxarnu* ‘we chose/elected’	שכנו *shaxnu* ‘they resided’	תופעה *tofaa* ‘phenomenon’	נמדוד *nimdod* ‘we will measure’
31.	מתחנו *mataxnu* ‘we stretched’	רטנו *ratnu* ‘they muttered/grumbled’	מחברת *maxberet* ‘notebook’	נפלוש *niflosh* ‘we will invade’
32.	לימדנו *limadnu* ‘we taught/trained’	זימנו *zimnu* ‘they convened’	הבהרה *havhara* ‘clarification’	נקטול *niqtol* ‘we will exteminate’
33.	שיחקנו *sixaknu* ‘we played’	רכנו *raxnu* ‘they leaned/stooped’	מברשת *mivreshet* ‘brush’	נספוג *nispog* ‘we will assorb’
34.	פחדנו *paxadnu* ‘we feared’	טיגנו *tignu* ‘they fried’	התחלה *hatxala* ‘start, beginning’	נרשום *nirshom* ‘we will write’
35.	גידלנו *gidalnu* ‘we grew/cultivated’	סימנו *simnu* ‘they marked’	הדגמה *hadgama* ‘illustration’	נטרוק *nitroq* ‘we will slam’
36.	זכרנו *zaxarnu* ‘we remembered’	קרנו *karnu* they beamed’	מרפסת *mirpeset* ‘porch’	נטבול *nitvol* ‘we will dip’

Appendix B - Critical stimuli for Experiment 4.2

	+Pers +Num	Unrelated	Target
1.	צברנו *tzavarnu* ‘we accumulated’	לבשת *lavashta* ‘you.sg.masc wore’	נבדוק *nivdok* ‘we will betray/cheat’
2.	בלטנו *balatnu* ‘we stood out’	גלשת *galashta* ‘you.sg.masc surfed’	נרכוש *nirkosh* ‘we will buy’
3.	פחדנו *paxadnu* ‘we feared’	נכחת *naxaxta* ‘you.sg.masc attended’	נצלול *nitzlol* ‘we will dive’
4.	גדלנו *gadalnu* ‘we grew up’	כתבת *katavta* ‘you.sg.masc wrote’	נמשוך *nimshox* ‘we will pull’
5.	למדנו *lamadnu* ‘we studied’	זחלת *zaxalta* ‘you.sg.masc crawled’	נגמור *nigmor* ‘we will finish’
6.	בחרנו *baxarnu* ‘we chose/elected’	סלחת *salaxta* ‘you.sg.masc forgave’	נבגוד *nivgod* ‘we will check’
7.	כשלנו *kashalnu* ‘we failed’	צחקת *tzaxaqta* ‘you.sg.masc laughed’	נדרוש *nidrosh* ‘we will require’
8.	קדמנו *kadamnu* ‘we preceded’	שמרת *shamarta* ‘you.sg.masc guarded/watched’	נמכור *nimkor* ‘we will sell’
9.	פתחנו *pataxnu* ‘we opened’	תמכת *tamxta* ‘you.sg.masc supported’	נרשום *nirshom* ‘we will write’
10.	מתחנו *mataxnu* ‘we stretched’	רמזת *ramzta* ‘you.sg.masc hinted’	נפגוש *nifgosh* ‘we will meet’
11.	דקרנו *dakarnu* ‘we stabbed’	זרחת *zaraxta* ‘you.sg.masc shone’	נפלוש *niflosh* ‘we will invade’
12.	זכרנו *zaxarnu* ‘we remembered’	תרמת *taramta* ‘you.sg.masc donated’	נצרוב *nitzrov* ‘we will scorch’
13.	צברנו *tzavarnu* ‘we accumulated’	נכחת *naxaxta* ‘you.sg.masc attended’	נטבול *nitvol* ‘we will dip’
14.	בלטנו *balatnu* ‘we stood out’	כתבת *katavta* ‘you.sg.masc wrote’	נסגור *nisgor* ‘we will close’
15.	גדלנו *gadalnu* ‘we grew up’	לבשת *lavashta* ‘you.sg.masc wore’	נספור *nispor* ‘we will count’
16.	פחדנו *paxadnu* ‘we feared’	תרמת *taramta* ‘you.sg.masc donated’	נסבול *nisbol* ‘we will endure’

17.	למדנו *lamadnu* 'we studied'	זחלת *zaxalta* 'you.sg.masc crawled'	נקפוץ *niqfotz* 'we will jump'
18.	בחרנו *baxarnu* 'we chose/elected'	סלחת *salaxta* 'you.sg.masc forgave'	נגנוב *nignov* 'we will steal'
19.	כשלנו *kashalnu* 'we failed'	זרחת *zaraxta* 'you.sg.masc shone'	נספוג *nispog* 'we will assorb'
20.	קדמנו *kadamnu* 'we preceded'	שמרת *shamarta* 'you.sg.masc guarded/watched'	נפסול *nifsol* 'we will disqualify'
21.	פתחנו *pataxnu* 'we opened'	צחקת *tzaxaqta* 'you.sg.masc laughed'	נמסור *nimsor* 'we will deliver/hand over'
22.	זכרנו *zaxarnu* 'we remembered'	גלשת *galashta* 'you.sg.masc surfed'	נמדוד *nimdod* 'we will measure'
23.	מתחנו *mataxnu* 'we stretched'	תמכת *tamxta* 'you.sg.masc supported'	נשבור *nishbor* 'we will break'
24.	דקרנו *dakarnu* 'we stabbed'	רמזת *ramzta* 'you.sg.masc hinted'	נפשוט *nifshot* 'we take off (clothes)'

Appendix C - Critical stimuli for Experiment 5.1

	Root and prefix	Root only	Unrelated	Target
1.	*aggiungere* ‘to add’	*ricongiungere* ‘to reconnect’	*concepire* ‘to conceive’	*aggiunto* ‘added (masc past participle)’
2.	*distorcere* ‘to distort’	*contorcersi* ‘to writhe’	*insultare* ‘to insult’	*distorto* ‘distorted (masc past participle)’
3.	*coinvolgere* ‘to involve’	*travolgere* ‘to crush/swamp’	*restituire* ‘to give back’	*coinvolto* ‘involved (masc past participle)’
4.	*trascorrere* ‘to spend (time)’	*soccorrere* ‘to provide first aid’	*rimandare* ‘to postpone/send again’	*trascorso* ‘(having) spent (time) (masc past participle)’
5.	*appeso* ‘to hang’	*dipendere* ‘to depend’	*restaurare* ‘to renovate’	*appeso* ‘hung (masc past participle)’
6.	*raccogliere* ‘to collect’	*accogliere* ‘to greet/accept’	*defluire* ‘to flow out from’	*raccolto* ‘collected (masc past participle)’
7.	*decomporre* ‘to decompose’	*proporre* ‘to propose’	*proclamare* ‘to proclaim’	*decomposto* ‘decomposed (masc past participle)’
8.	*promettere* ‘to promise’	*trasmettere* ‘to transmit’	*confidare* ‘to trust’	*promesso* ‘promised (masc past participle)’
9.	*sopravivere* ‘to survive’	*convivere* ‘to live together’	*comparare* ‘to compare’	*sopravissuto* ‘survived (masc past participle)’
10.	*pretendere* ‘to demand’	*attendere* ‘to wait’	*consentire* ‘to allow’	*preteso* ‘demanded (masc past participle)’
11.	*comprendere* ‘to understand’	*riprendere* ‘to pick up/re-take’	*riportare* ‘to bring back/report’	*compreso* ‘understood (masc past participle)’
12.	*uccidere* ‘to kill’	*decidere* ‘to decide’	*respirare* ‘to breathe’	*ucciso* ‘killed (masc past participle)’
13.	*correggere* ‘to correct’	*sorreggere* ‘to support’	*rimandare* ‘to postpone/send again’	*corretto* ‘corrected (masc past participle)’
14.	*deprimere* ‘to depress’	*comprimere* ‘to compress’	*insultare* ‘to insult’	*depresso* ‘depressed (masc past participle)’
15.	*accorgersi* ‘to realise’	*scorgere* ‘to glimpse’	*restituire* ‘to give back’	*accorto* ‘observant (masc past participle)’
16.	*devolvere* ‘to devolve’	*evolvere* ‘to evolve’	*restaurare* ‘to renovate’	*devoluto* ‘devolved (masc past participle)’

17.	*percuotere* 'to pummel'	*scuotere* 'to shake'	*defluire* 'to flow out from'	*percosso* 'pummelled (masc past participle)'
18.	*schiudere* 'to open'	*rinchiudere* 'to shut in'	*riportare* 'to bring back/report'	*schiuso* 'opened (masc past participle)'
19.	*diffondere* 'to spread'	*confondere* 'to confuse'	*concepire* 'to conceive'	*diffuso* 'widespread (masc past participle)'
20.	*distrarre* 'to distract'	*estrarre* 'to extract'	*proclamare* 'to proclaim'	*distratto* 'distracted (masc past participle)'
21.	*estinguere* 'to estinguish'	*distinguere* 'to distinguish'	*comparare* 'to compare'	*estinto* 'estinguished (masc past participle)'
22.	*respingere* 'to reject'	*dipingere* 'to paint'	*consentire* 'to allow'	*respinto* 'rejected (masc past participle)'
23.	*presumere* 'to presume'	*assumere* 'to hire'	*confidare* 'to trust'	*presunto* 'presumed (masc past participle)'
24.	*assolvere* 'to assolve'	*risolvere* 'to solve/resolve'	*respirare* 'to breathe'	*assolto* 'assolved (masc past participle)'
25.	*prevalere* 'to prevail'	*avvalersi* 'to avail (oneself) of'	*rimandare* 'to postpone/send again'	*prevalso* '(that has) prevailed (masc past participle)'
26.	*tradurre* 'to translate'	*ridurre* 'to reduce'	*insultare* 'to insult'	*tradotto* 'translated (masc past participle)'
27.	*annettere* 'to annex'	*connttere* 'to connect'	*restituire* 'to give back'	*annesso* 'annexed (masc past participle)'
28.	*deludere* 'to disappoint'	*eludere* 'to evade/elude'	*restaurare* 'to renovate'	*deluso* 'disappointed/embittered (masc past participle)'
29.	*pervadere* 'to permeate'	*invadere* 'to invade'	*defluire* 'to flow out from'	*pervaso* 'permeated (masc past participle)'
30.	*commuovere* 'to move, touch'	*promuovere* 'to promote'	*riportare* 'to bring back/report'	*commosso* 'moved, touched (masc past participle)'
31.	*interrrompere* 'to interrupt'	*corrompere* 'to corrupt'	*concepire* 'to conceive'	*interrotto* 'interrupted (masc past participle)'
32.	*restringere* 'to tighten/restrict'	*costringere* 'to force'	*proclamare* 'to proclaim'	*ristretto* 'tightened/restricted (masc past participle)'
33.	*rivisto* 'to see again'	*prevedere* 'to foresee'	*comparare* 'to compare'	*rivisto* 'seen again (masc past participle)'

34.	*prescrivere* ‘to prescribe’	*descrivere* ‘to describe’	*consentire* ‘to allow’	*prescritto* ‘prescribed (masc past participle)’
35.	*includere* ‘to include’	*concludere* ‘to conclude’	*confidare* ‘to trust’	*incluso* ‘included (masc past participle)’
36.	*accendere* ‘to switch on’	*scendere* ‘to get off’	*respirare* ‘to breathe’	*acceso* ‘switched on (masc past participle)’

Appendix D - Critical stimuli for Experiment 6.1

	+Syn+Phon	+Syn-Phon	-Syn+Phon	-Syn-Phon	Target
1.	*arredamento* ‘furniture’	*attivazione* ‘activation’	*volontariamente* ‘willingly’	*inevitabile* ‘unavoidable’	*collegamenti* ‘connections’
2.	*turbamento* ‘restlessness’	*continuazione* ‘continuation’	*tranquillamente* ‘calmly’	*accettabile* ‘acceptable’	*possedimenti* ‘belongings’
3.	*coinvolgimento* ‘involvement’	*creazione* ‘creation’	*dolcemente* ‘sweetly’	*indispensabile* ‘necessary’	*trattamenti* ‘treatments’
4.	*equipaggiamento* ‘equipment’	*incoronazione* ‘coronation’	*pubblicamente* ‘publicly’	*affidabile* ‘reliable’	*rivestimenti* ‘coatings’
5.	*giuramento* ‘oath’	*valutazione* ‘evaluation’	*giustamente* ‘justly/rightly’	*irritabile* ‘grumpy’	*allenamenti* ‘trainings’
6.	*licenziamento* ‘layoff/termina tion’	*tentazione* ‘temptation’	*attentamente* ‘carefully’	*imperdonabile* ‘unforgivable’	*risarcimenti* ‘compensations’
7.	*fidanzamento* ‘betrothal’	*spedizione* ‘shipping/ expedition’	*felicemente* ‘happily’	*adorabile* ‘adorable’	*rallentamenti* ‘(traffic) slowing downs’
8.	*isolamento* ‘isolation’	*ispirazione* ‘inspiration’	*brutalmente* ‘brutally’	*rispettabile* ‘decent’	*accoppiamenti* ‘matings’
9.	*addestramento* ‘training’	*abitazione* ‘dwelling/resid	*gentilmente* ‘gently’	*insopportabile* ‘unbearable’	*chiarimenti* ‘clarifications’
10.	*sollevamento* ‘lifting/raising’	*collaborazione* ‘collaboration’	*disperatamente* ‘desperately’	*amabile* ‘lovable’	*aggiornamenti* ‘updates’
11.	*rapimento* ‘kidnapping/a bduction’	*documentazione* ‘documentation	*diversamente* ‘differently’	*gonfiabile* ‘inflatable’	*maltrattamenti* ‘abuses’
12.	*avvelenamento* ‘poisoning’	*abilitazione* ‘qualification’	*rapidamente* ‘quickly’	*rintracciabile* ‘traceable’	*comportamenti* ‘behaviours’
13.	*coinvolgimento* ‘involvement’	*continuazione* ‘continuation ’	*dolcemente* ‘sweetly’	*inevitabile* ‘unavoidable’	*miglioramenti* ‘improvements’
14.	*licenziamento* ‘layoff/termina tion’	*creazione* ‘creation’	*pubblicamente* ‘publicly’	*amabile* ‘lovable’	*tradimenti* ‘betrayals’

15.	*arredamento* 'furniture'	*spedizione* 'shipping/ expedition'	*felicemente* 'happily'	*affidabile* 'reliable'	*combattimenti* 'battles'
16.	*fidanzamento* 'betrothal'	*incoronazione* 'coronation'	*rapidamente* 'quickly'	*indispensabile* 'necessary'	*allevamenti* 'animal farms'
17.	*isolamento* 'isolation'	*valutazione* 'evaluation'	*giustamente* 'justly/rightly'	*irritabile* 'grumpy'	*abbinamenti* 'couplings'
18.	*giuramento* 'oath'	*tentazione* 'temptation'	*diversamente* 'differently'	*rintracciabile* 'traceable'	*accampamenti* 'camps'
19.	*sollevamento* 'lifting/raising'	*attivazione* 'activation'	*tranquillamente* 'calmly'	*imperdonabile* 'unforgivable'	*insegnamenti* 'teachings'
20.	*rapimento* 'kidnapping/a bduction'	*abilitazione* 'qualification'	*attentamente* 'carefully'	*adorabile* 'adorable'	*inseguimenti* 'chases'
21.	*addestramento* 'training'	*abitazione* 'dwelling/resid ence'	*volontariamente* 'willingly'	*rispettabile* 'decent'	*cambiamenti* 'changes'
22.	*equipaggiamento* 'equipment'	*ispirazione* 'inspiration'	*disperatamente* 'desperately'	*accettabile* 'acceptable'	*schieramenti* 'military line-ups'
23.	*turbamento* 'restlessness'	*documentazione* 'documentatio n'	*brutalmente* 'brutally'	*gonfiabile* 'inflatable'	*approfondimenti* 'in-depth analyses'
24.	*avvelenamento* 'poisoning'	*collaborazione* 'collaboration'	*gentilmente* 'gently'	*insopportabile* 'unbearable'	*divertimenti* 'entertainments'
25.	*licenziamento* 'layoff/termina tion'	*attivazione* 'activation'	*dolcemente* 'sweetly'	*rintracciabile* 'traceable'	*suggerimenti* 'suggestions'
26.	*coinvolgimento* 'involvement'	*incoronazione* 'coronation'	*pubblicamente* 'publicly'	*affidabile* 'reliable'	*trasferimenti* 'tranfers'
27.	*arredamento* 'furniture'	*creazione* 'creation'	*rapidamente* 'quickly'	*irritabile* 'grumpy'	*spostamenti* 'repositionings'
28.	*fidanzamento* 'betrothal'	*collaborazione* 'collaboration'	*giustamente* 'justly/rightly'	*indispensabile* 'necessary'	*mutamenti* 'changes'
29.	*isolamento* 'isolation'	*valutazione* 'evaluation'	*tranquillamente* 'calmly'	*insopportabile* 'unbearable'	*bombardamenti* 'bombings'
30.	*giuramento* 'oath'	*abilitazione* 'qualification'	*felicemente* 'happily'	*imperdonabile* 'unforgivable'	*travestimenti* 'disguises'

31.	*sollevamento* 'lifting/raising'	*documentazione* 'documentatio n'	*diversamente* 'differently'	*rispettabile* 'decent'	*abbonamenti* 'subscriptions'
32.	*avvelenamento* 'poisoning'	*tentazione* 'temptation'	*disperatamente* 'desperately'	*amabile* 'lovable'	*ringraziamenti* 'acknowlegdeme nts'
33.	*equipaggiamento* 'equipment'	*spedizione* 'shipping/ expedition'	*attentamente* 'carefully'	*gonfiabile* 'inflatable'	*versamenti* 'bank deposits'
34.	*addestramento* 'training'	*continuazione* 'continuation'	*volontariamente* 'willingly'	*adorabile* 'adorable'	*pagamenti* 'payments'
35.	*turbamento* 'restlessness'	*abitazione* 'dwelling/reside	*brutalmente* 'brutally'	*accettabile* 'acceptable'	*insediamenti* 'settlements'
36.	*rapimento* 'kidnapping/a bduction'	*ispirazione* 'inspiration'	*gentilmente* 'gently'	*inevitabile* 'unavoidable'	*fallimenti* 'failures'
37.	*arredamento* 'furniture'	*attivazione* 'activation'	*volontariamente* 'willingly'	*accettabile* 'acceptable'	*finanziamenti* 'fundings'
38.	*addestramento* 'training'	*creazione* 'creation'	*dolcemente* 'sweetly'	*affidabile* 'reliable'	*investimenti* 'investments'
39.	*isolamento* 'isolation'	*incoronazione* 'coronation'	*tranquillamente* 'calmly'	*indispensabile* 'necessary'	*festeggiamenti* 'celebrations'
40.	*coinvolgimento* 'involvement'	*collaborazione* 'collaboration'	*brutalmente* 'brutally'	*imperdonabile* 'unforgivable'	*appostamenti* 'stakeouts'
41.	*fidanzamento* 'betrothal'	*valutazione* 'evaluation'	*giustamente* 'justly/rightly'	*amabile* 'lovable'	*ornamenti* 'decorations'
42.	*giuramento* 'oath'	*abilitazione* 'qualification'	*attentamente* 'carefully'	*irritabile* 'grumpy'	*condimenti* 'dressings'
43.	*licenziamento* 'layoff/termina tion'	*documentazione* 'documentatio n'	*felicemente* 'happily'	*gonfiabile* 'inflatable'	*ragionamenti* 'reasonings'
44.	*sollevamento* 'lifting/raising'	*tentazione* 'temptation'	*pubblicamente* 'publicly'	*adorabile* 'adorable'	*incoraggiamenti* 'encouragement s'
45.	*avvelenamento* 'poisoning'	*continuazione* 'continuation'	*disperatamente* 'desperately'	*rintracciabile* 'traceable'	*sentimenti* 'feelings'
46.	*rapimento* 'kidnapping/a bduction'	*spedizione* 'shipping/ expedition'	*gentilmente* 'gently'	*insopportabile* 'unbearable'	*avvistamenti* 'sightings'

47.	*turbamento* ‘restlessness’	*abitazione* ‘dwelling/residence’	*diversamente* ‘differently’	*inevitabile* ‘unavoidable’	*ripensamenti* ‘afterthoughts’
48.	*equipaggiamento* ‘equipment’	*ispirazione* ‘inspiration’	*rapidamente* ‘quickly’	*rispettabile* ‘decent’	*fraintendimenti* ‘misunderstandings’

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