Productivity and Anticipation in Language Processing

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Productivity is a property of rules which is mainly discussed in the context of word formation. Anticipation is a phenomenon that can be observed in the intentional execution of procedures. In language processing it is subconscious. In this paper, the object of investigation is the interaction of productivity of word formation rules and anticipation in language processing. As a framework, Jackendoff's (2002) Parallel Architecture is used, but with a separate component of word formation, as argued in ten Hacken (2019). Word formation is compared to analogy in its capacity to add new words to and organize entries of a speaker's mental lexicon. Both contribute to the infrastructure for anticipation in the retrieval of lexicon entries, although not in exactly the same way.

1. Introduction

The question to be addressed here concerns the interaction of productivity and anticipation. Although they both have to do with the frequency of events, the perspectives are quite different. Anticipation is a concept in language processing, whereas productivity is a property of rules. As a starting point, I will therefore introduce the contrasting perspectives of anticipation (section 2) and productivity (section 3). The domain where the issue of productivity is most relevant is word formation. Section 4 proposes an account of word formation rules as a preparation for the discussion of the position of productivity in language processing, the area in which anticipation is naturally at home (section 5). In section 6, I will turn to the constrast between word formation rules and analogy, which highlights some crucial differences between the type of frequency involved in productivity and in anticipation. Section 7 summarizes the conclusions.

2. Anticipation in communication

The role of anticipation in successful communication can be illustrated with the two examples in (1).

(1) a. Are you alright there?
     b. Who did you believe John to have seen?

Both examples in (1) are questions, but they have a very different communicative value. In Britain, (1a) is the usual starting point for a service conversation at a counter of, for instance, the butcher's section of a supermarket. This is what the shop assistant says to the customer whose turn it is to order. The expected answer is a specification what the customer wants to get. An answer "yes" is possible from a communicative perspective, but it means that one does not want to order anything. The question in (1b) is used by Chomsky (1981: 172) in the discussion of movement as a syntactic operation in English. The issues to be accounted for are how *who* can be interpreted as the object of *seen* and why it is at the start of the sentence.

An answer to the question asked in (1b) is not expected, nor is a clarification question of which *John* is referred to.

For a felicitous communicative use of the questions in (1), anticipation is crucial. Anticipation is the use of available cues to reduce the range of probable utterances. For an appropriate reaction to (1a), it is not sufficient to know English. When I first encountered (1a) in a British supermarket, I was confused. The shop assistant was amused by this, perhaps realizing for the first time the difference between the literal and intended meanings of his utterance. In the case of (1b), although it is taken from a printed version, it is originally from a lecture. Although knowledge of English is sufficient for an interpretation of the meaning of (1b), for an appropriate reaction it is necessary to take into account the context of the lecture and the intention of clarifying a theoretical linguistic point in addition to the theoretical framework assumed in the discussion. In fact, the reaction will rather be a silent processing of this point than the production of an answer.

In this discussion, I will adopt Jackendoff's (2002) Parallel Architecture (PA) as a basic framework. PA assumes that for any linguistic expression, there are three representations, connected as in Fig. 1.
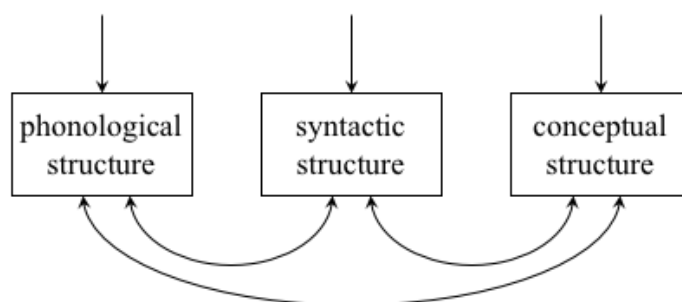

Figure 1: Parallel Architecture, after Jackendoff (2002: 125)

As represented in Fig. 1, each linguistic expression has a phonological, a syntactic and a conceptual structure. The arrows above them stand for the formation rules. Crucially, each representation has its own set of formation rules. The double-headed arrows below the boxes stand for the linking rules that connect the representations. They ensure that the three representations can be interpreted as encoding different aspects of the same expression. They can also play a role in the formation of the representations when, for instance, aspects of the meaning, represented in conceptual structure, influence the syntactic structure.

In taking Fig. 1 as a background for an account of (aspects of) communication, it is important to keep in mind that the entire structure is realized only in individual speakers. Suppose we have two speakers of English, Emma and Frank, and Emma says (1b) to Frank. For Emma the communication starts from an idea (I_E) she has. She produces a complete representation of an expression corresponding to I_E. In doing so, she is likely to start primarily from the right in Fig. 1, but there is no need for her to work through the arrows of the figure in any predetermined fashion. Her language competence enables her to produce the representation in various ways, because language has a lot of redundancy and alternative routes to arrive at the same result. After producing this representation, Emma makes the utterance (1b). This is a purely acoustic event. When Frank hears (1b), he processes the signal to build up his own representation. Clearly, the acoustic input triggers primarily the formation rules for phonological structure, but the exact path is again not pre-determined. The difficulty we have in transcribing a language we do not understand is an indication of

how important the syntactic and conceptual structures are in parsing the acoustic input. At the end of the processing stage, Frank has built up an idea (I_F) of what Emma said. There is no idea associated with the acoustic event, only I_E and I_F, the former in Emma's and the latter in Frank's mind. Successful communication is then not so much like passing on a package (the idea) wrapped in a language, but rather the result of Frank building up an I_F that is similar enough to Emma's I_E.

Jackendoff (2002) calls the place where all rules represented by the arrows in Fig. 1 are stored the *lexicon*. This is less strange than it may seem. In a more common interpretation of *lexicon*, it will at least contain the words of a language. Words are units linking sound and meaning. As such, they have a phonological representation and a conceptual representation, which provides the information for the corresponding structures in Fig. 1. They typically have a syntactic category as well, which can be taken as their syntactic structure. In the case of (1a), we have a sentence of four words. For speakers who know the expression and its communicative function, it is unlikely that each time they say or hear (1a), they build it up from the four words it consists of. Rather, they have it stored as a single expression. It is an example of what Wray (2002) calls *Formulaic Language*. This means that (1a) is also a lexical entry. It has more structure at each level than an entry for, for instance, *book*, but it is not of a completely different type. Jackendoff (2002: 152–182) argues in detail that there is no boundary in the continuum from lexical entries for words, through idioms to syntactic rules. In an entry for a syntactic rule, the phonological structure and the conceptual structure will be entirely underspecified. The degree of specification of these structures decreases gradually when we move from idioms to syntactic rules.

It is important to see, then, that the constellation depicted in Fig. 1 is used in two distinct but connected ways. On one hand it represents the sound, structure and meaning of a linguistic expression. On the other hand, it represents a speaker's lexicon. This is the same distinction as Chomsky (1965: 4) makes between *performance* and *competence*. Performance consists of individual expressions, competence of an individual speaker's knowledge. For Jackendoff, competence is the lexicon. The lexicon is individual, because it is realized in the mind of an individual speaker.

Let us now consider the place of anticipation in language processing. Anticipation is relevant in the reception and interpretation of an expression. That is to say, we have acoustic or visual (written) input as the starting point. Jackendoff (2002: 207–218) discusses lexical access and assigns an important role to priming. The mental lexicon is not a list of items. It is organized in a multi-dimensional structure which is laid out in such a way that the most likely entries can be considered first. Knowledge of the situation can be taken into account in organizing this structure. One sense of anticipation concerns the organization of the entries in the mental lexicon. This is often called *priming*.

In processing an utterance, the hearer or reader builds up a representation with three connected structures as in Fig. 1 for the expression that is recognized. Although this process is relatively fast, it is by no means instantaneous. The arrows in Fig. 1 indicate possible directions in which existing information in a preliminary representation can be used to add further specification. The additional information is taken from the input, but its integration is prepared for by the partial representation that already exists. This is a second type of anticipation.

There are then at least two types of anticipation. The first uses the lexicon as a general infrastructure and can be adapted by knowledge about the situation and about the speaker or

writer, the second uses the structure as it is being built for the expression and depends more on syntactic and collocational generalizations.

3. The nature of productivity

Productivity is a property of rules. The concept of *rule* is central in generative linguistics and has been the subject of a lot of controversy, especially in the earlier decades of its history (cf. Botha 1989). Chomsky (1964: 7) formulated the focus of generative linguistics as in (2).

(2)   The central fact to which any significant linguistic theory must address itself is this: a mature speaker can produce a new sentence of his language on the appropriate occasion, and other speakers can understand it immediately.

The necessity of rules in generative grammar emerges from the need to account for the production of new sentences. Rules make it possible to construct infinitely many sentences on the basis of a finite set of stored knowledge. By means of rules, new sentences can be generated. Part of the philosophical discussion this triggered turned on the status of these rules, because in the context of language, *rule* tends to be interpreted as French *règle* in (3).

(3)   La principale mission de l'Académie sera de travailler avec tout le soin et toute la diligence possibles à donner des règles certaines à notre langue et à la rendre pure, éloquente et capable de traiter les arts et les sciences.[1]

In (3), we find an extract from the original statutes of the *Académie française* (1635, Art. XXIV). The intention in (3) is to formulate rules that can be imposed on speakers. Chomsky's idea of rules is rather influenced by empirical and formal sciences. In an empirical science such as astronomy, the purpose is to construct a model of the outside world that explains our observations. Rules are then rather like natural laws. In the case of language, they are a model of a speaker's competence. In formal sciences such as logic, theorems are derived from axioms. Rules are the mechanism by which such a derivation can take place. In the case of language, rules are used to generate an expression. This double inspiration explains why the productivity of rules can be an issue. Rules are at the same time used as a description of the competence and as a mechanism for generating expressions. Not all rules need to fulfil both functions. Productive rules are those rules that are involved in the generation of *new* expressions. Other rules may describe the structure of existing expressions without being generalizable to novel ones.

The key area where productivity is an issue is morphology. In (2), Chomsky refers to sentences. For syntactic rules, it is generally assumed that they are productive. Even for lexicalized sentences such as (1a), the rules involved are productive, because they also generate non-lexicalized sentences. An early and influential application of this idea to morphology is due to Henk Schultink (1924–2017), a Dutch morphologist and one of the first linguists to introduce generative linguistics in Europe. In (4), his definition of *morphological productivity* is given (1961: 113).

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[1] 'The main mission of the Academy is to work with all possible care and diligence in order to set up definite rules for our language and to make it pure, eloquent, and capable of treating the arts and sciences.' [my translation, PtH]

(4)   Onder produktiviteit als morfologisch fenomeen verstaan we dan de voor taalgebruikers bestaande mogelijkheid door middel van het morfologisch procédé dat aan de vorm-betekenis-correspondentie van sommige hun bekende woorden ten grondslag ligt, onopzettelijk een in principe niet telbaar aantal nieuwe formaties te vormen.[2]

The key elements of (4) are *onopzettelijk* ('unintentionally') and *in principe niet telbaar* ('in principle not countable'). These are in fact properties that are typical of syntactic rules. They can also be applied quite straightforwardly to many inflectional categories. Thus, the plural formation of nouns in English is a case in point. The productivity of this rule underlies Berko's (1958) well-known *wug* test.

For word formation, it is less straightforward to apply (4), because unlike English plural formation, word formation rules are generally subject to constraints of various types that restrict the unintentionality and uncountability of their application. A proper application of *productivity* as a label for properties of word formation rules requires a more sophisticated analysis of the nature of these rules, which will be undertaken in section 4.

Before turning to word formation, it is worth pointing out a difference between rules as assumed in Chomsky's generative grammar and the rules in Jackendoff's PA as represented in Fig. 1. In Chomsky's original formalism, used for instance in Chomsky (1957, 1965), rules are rewrite rules or transformation rules. Such rules have a clearly specified input and produce an output based on this input. As opposed to such a procedural interpretation of rules, PA adopts a purely declarative interpretation. Rules are lexical entries. These entries state information, but they do not specify any process. Rather than dividing the information into a condition for application (input) and specification of change (output), a lexical entry correlates information at the three structures of representation in Fig. 1. For a syntactic rule, the parts on phonological and conceptual structure may be empty, but this does not make it a different type of rule in principle. In the course of the process of building up a representation, we have at some point a partial representation (R_n) of an expression. Now all entries that do not conflict with R_n can in principle be applied. An entry E that matches (i.e. does not conflict with) R_n can be used to extend it to R_{n+1}. R_{n+1} contains all information from R_n and all information from E. This declarative interpretation of rules is a crucial feature of Jackendoff's (2002) PA.

4. The nature of word formation rules

Here I will present a view of word formation that diverges from the one adopted by Jackendoff (2002, 2016). A more detailed presentation and argumentation for this treatment of word formation can be found in ten Hacken (2019). My theory of word formation is compatible with the foundational assumptions of PA and diverges only in the assessment of the nature of word formation. As an example of word formation, let us consider Dutch (5).

(5)   a. drinken   ('drink$_V$')

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[2] 'Under productivity as a morphological phenomenon, we understand the possibility for language users to create new formations unintentionally and in an in principle not countable number, by means of a morphological procedure that is at the basis of the form-meaning correspondence of some words they know.' [my translation, PtH]

b. drinkbaar   ('drinkable')

The verb in (5a) is given in the infinitive, the usual citation form. The stem is *drink*. It is the input of a word formation rule whose output is (5b). The rule can be described as in (6).

(6)   a. PS: add *-baar* to the base
        b. SS: V $\Rightarrow$ A
        c. CS: add potential and passive components to the meaning of the base

The description in (6) is quite informal and specifies what is changed by the word formation rule at each of the three structures in Fig. 1. In an intuitive sense, (6) is used to create (5b) from (5a). An important question at this point is where this creation process takes place and what it results in. There are two possible answers to this. One is that (6) is applied when producing an expression in the performance. The other possibility is that (6) is applied entirely in the lexicon and affects the speaker's competence, producing an entry for (5b) in their lexicon.

      In order to explore the consequences of each of these two interpretations, let us suppose that Gea and Hans are two speakers of Dutch. Gea has *drinkbaar* as an entry in her mental lexicon, Hans only *drinken* and the rule in (6). Is it possible to notice this difference? Jackendoff (2002: 154–167) argues for a model of morphology where for productive morphological processes it is not possible to observe this difference readily in communication. This is the case, for instance, for regular plurals of nouns in English. Their existence, form and meaning is entirely predictable. Whether a speaker stores, for instance, *cars* or forms it during processing influences processing time and storage requirements, but not performance. For *drinkbaar*, we would expect the same if (6) were an entirely productive rule. The difference in Gea's and Hans's handling of the word would only be observable with advanced psycholinguistic tests or neurolinguistic instruments.

      When we observe actual use of *drinkbaar* in a corpus, we find examples such as (7). These examples were edited from CHN (2013) to make them shorter without significant changes in the meaning of the parts reproduced in (7).

(7)   a. De bewoners kregen een schrijven dat het leidingwater twee weken niet drinkbaar zou   zijn.
          'The residents received a letter that the tap water two weeks not drinkable would be', i.e. would not be drinkable for two weeks
        b. De wijn zal pas echt drinkbaar zijn tijdens een eventuele tweede ambtstermijn van de   president.
          'The wine will only really drinkable be during a possible second term of the president', i.e. will only be really drinkable

Both in (7a) and in (7b), the meaning of *drinkbaar* is more specific than the combination of (5a) and (6). The meanings of the adjective in (7a) and (7b) are slightly different and depend on the noun that is modified. We can thus have pairs such as (8) and (9).

(8)   a. drinkbaar water   ('drinkable water')
        b. water dat zonder schade voor de gezondheid kan worden gedronken
          'water that can be consumed without damage to one's health'

(9) a. drinkbare wijn   ('drinkable wine')
     b. wijn die voldoende gerijpt is om zijn smaak te ontwikkelen
         'wine that has matured sufficiently to develop its taste'

The frequency in CHN (2013) indicates that the sense in (8a) is much more common than the one in (9a). The paraphrases in (8b) and (9b) have an approximately equivalent meaning. The difference between the word and the paraphrases is that the paraphrases describe a property of *water* and *wijn*, whereas the word *drinkbaar* names this property as a concept.

When Gea says (7a) to Hans, assuming that she has *drinkbaar* as an entry in her lexicon, she can immediately associate the meaning described in (8b) with the entry. If Hans builds up *drinkbaar* from (5a) and (6), the interpretation process will be more complex. In a literal sense, any water is *drinkbaar*, because it is liquid. This is obviously not compatible with (7a), because *leidingwater* ('tap water') is clearly a kind of water. An important cue for Hans is that *drinkbaar* is a word. If he does not know the word, his assumption will be that it refers to a new concept. The input of the entry (5a) and the rule (6) as well as the context of use can be used to make a hypothesis on the meaning of this concept. The possible uses of the word formation rule in (6) in relation to the input in (5a) can then be summarized as in (10).

(10) a. Formation of the new word *drinkbaar*
      b. Understanding of the new word *drinkbaar*
      c. Extension of the lexicon with *drinkbaar*
      d. Connection of *drinkbaar* with *drinken*

We may intuitively think of (10a) as the central purpose of word formation rules. However, their use in this way is quite rare. (10b–d) are much more common. These three are intimately connected. If Hans encounters *drinkbaar* as a new word in a context such as (7a), he will use (6) in interpreting it. Ideally, the result of his inferences will be something like the paraphrase in (8b). Given the amount of work involved in the interpretation process, he will probably also store *drinkbaar* in his lexicon and use (6) for (10c–d), so that next time he encounters the word, retrieval is possible by (10c) and efficient by (10d). This is especially frequent for children.

The use in (10a) is the naming use of word formation. In naming, we apply a name to a concept. The fact that Gea in our example knows *drinkbaar* does not imply that she has formed it by naming. The most common origin of new words of this type is the process described for Hans above. However, at least one speaker must have come up with the word for the first time. Let us suppose Gea was one of those speakers who started using *drinkbaar* without first hearing or reading it. When using *drinkbaar* as a name for the concept, she will have made the decision that a paraphrase such as (8b) is not sufficient and looked for a word instead. The selection of the word formation rule in (6) and the entry in (5a) is not predetermined at this stage. What is predetermined, however, is the meaning of whatever word she will choose for the concept. This is what I call *onomasiological coercion* (ten Hacken 2019: 67).

The ways word formation rules are used as listed in (10) are essentially different from the way lexicon entries are used. Lexicon entries constitute the linguistic competence of a speaker and are used in producing and interpreting performance. Word formation rules are used to extend the lexicon. As such, they change a speaker's competence and their use in producing and interpreting performance is derived from this. As argued in more detail in ten

Hacken (2019), word formation rules are not in Fig. 1, but in a separate component that works on the lexicon.

5. Productivity and language processing

When we want to connect anticipation and productivity, language processing is the area we have to look at. As we saw in section 2, anticipation is important in two places in language processing, on one hand in the organization of the lexicon entries to optimize retrieval and on the other in the building of a full representation of an expression in performance. Productivity is especially interesting in the context of word formation. Assuming the functions of a word formation rule to be the ones listed in (10), they can connect to both types of anticipation. Whereas (10a-b) refer to the process of producing and interpreting performance, i.e. language processing, (10c–d) refer to the organization of the mental lexicon, which provides the infrastructure for language processing.

In (4), we saw an approach to productivity that centred on two properties, the unintentionality of rule application and the unlimited number of rule applications. The proper interpretation of Schultink's (1961) concept of *unintentionality* has raised a lot of discussion. Van Marle (1985) distinguishes *productivity* and *creativity*, where the former maintains unintentionality and the latter does not. Both are deemed to be properties of rules that can be used to create new words. In this narrow interpretation of *productivity*, word formation rules are arguably not productive in general. The formation of a new word as in (10a) requires a conscious, i.e. intentional, naming act. The understanding of a new word as in (10b) requires interpretation of the type we have seen for *drinkbaar* in the discussion of (7a). The necessity of a conscious, context-sensitive interpretation is highlighted when we contrast *drinkbaar* as a property of water in (7a) with *drinkbaar* as a property of wine in (7b).

Turning to the second of Schultink's defining properties of *productivity*, the unlimited number is conspicuously modified by *in principle*. The crucial point here is how the number of applications of a rule is measured. As an example, we can take the rule illustrated in (11).

(11) a. geweld   ('violence')
      b. geweldloos   ('without violence, nonviolent')

Like *-baar* in (5), also *-loos* in (11) is a suffix forming adjectives. However, the suffix *-loos* attaches to nouns. Clearly, we have to allow for a rule to specify the syntactic category of its input. Otherwise, no morphological rule would apply in an in principle unlimited number of cases. As explained by de Haas & Trommelen (1993: 291), *-baar* applies in general only to transitive verbs. Is it allowed to restrict the domain of application in this way? If not, the rule with *-baar* is not productive. If it is allowed, the question is where the boundary for such constraints is put. If any constraint is allowed, the condition is vacuous, because we would be able to constrain the domain to the list of attested input words by assigning them an arbitrary feature.

Apart from the practical problem of measuring productivity, there are also more conceptual problems. In section 4, we considered two speakers of Dutch, Gea and Hans, one of whom had *drinkbaar* in her mental lexicon, the other not. Does this mean that the word exists? Another such problem directly concerns the naming function of word formation. Whether a word is formed depends on its need as a name. When a word is not used, it can be because it is not a well-formed word or because the word is simply not necessary.

Distinguishing these two requires that we determine in advance whether the formation of a word is possible or not. But if we do this, determining the productivity of a word formation rule becomes a circular reasoning.

What we can conclude at this point is that Schultink's (1961) definition of *productivity* in (4) is not optimally suited to our purposes. A more detailed analysis of productivity is proposed by Corbin (1987: 176–178). She distinguishes three notions that together constitute productivity:

- *Disponibilité*: This is the property of a rule that it can be used for the formation of new words.
- *Rentabilité*: This is the property that a rule is frequently used for the formation of new words.
- *Régularité*: This is the property that the result of the application of the rule is predictable.

Each of these three notions catches a different aspect of what has been called *productivity*. Whereas *disponibilité* and *rentabilité* are properties of a rule, *régularité* can only be indirectly predicated of a rule. It is a property of an individual application. The fact that *schijnbaar* ('apparently') with the base verb *schijnen* ('appear') does not fully conform to (6) is first of all a property of the individual formation. We can also single out *disponibilité* as a property of the system, whereas *rentabilité* and *régularité* are properties of the use of the system. Thus, only *disponibilité* is a property of the speaker's competence. On this basis, Corbin (1987: 177) retains only *disponibilité* as the relevant property of a productive rule.

In Jackendoff's (2002: 155–159) discussion of productivity, he concentrates on what Corbin calls *régularité*. He uses a syntactic interpretation of productivity, which highlights Schultink's idea of unintentionality. *Rentabilité* can be seen as an emergent property in PA, because it generalizes over the use of rules. In terms of Jackendoff's (1975) redundancy rules, it determines the cost of referring to a generalization. In Schultink's definition in (4), it corresponds to the in principle unlimited number of applications.

For the representation of *disponibilité*, the model I propose in ten Hacken (2019), which adds a separate word formation component, has a natural solution. All and only the word formation rules that have this property are in the word formation component.

Let us now consider how each of the types of productivity contributes to anticipation. We have to distinguish the two places in processing where anticipation can occur. The first concerns the hierarchy of lexicon entries that determines the search sequence for a relevant entry. Here *disponibilité* is a factor, because whether a rule is in the word formation component determines whether it is considered as a potential rule for (10b). *Rentabilité* is also important, because it influences the hierarchy of rules, i.e. which rules are more likely to be used. The second place in language processing where anticipation can be observed is in the structure building process. Here *disponibilité* is not a major factor. Crucial at this stage is (10d). The strength of the connection between entries is determined by *rentabilité* and *régularité*. In the case of *rentabilité*, we have a measure of the prominence of a rule. In *régularité*, the amount of extra processing effort beyond the retrieval of the rule is highlighted. This means that all three notions of productivity proposed by Corbin (1987) interact with anticipation, but they do so in different ways and in different places.

6. Word formation and analogy

Anticipation has a direct link to analogy. Analogy can be found in language in various contexts, but here it is most interesting as an alternative to word formation rules. Mattiello (2017) is an example of a study that highlights the importance of analogy, not only as an alternative but also as a contributing factor to the application of word formation rules. In an analogical account of the pair in (5), we need another pair, e.g. (12).

(12) a. eten   ('eat')
      b. eetbaar   ('edible')

In (12a), we again have the infinitive of a verb. Because of orthographic rules of Dutch, the same sound is written <e> at the start of (12a), where it is in an open syllable, and <ee> in (12b), where the syllable is closed. The meaning of (12b) is not exactly the same as what (6) predicts and the divergence is very similar to what we observed in the case of (5). Thus we can talk about *eetbare paddestoelen* ('edible mushrooms') parallel to *drinkbaar water* in (7a). In CHN (2013) *eetbaar* is much more frequent than *drinkbaar* (1064 against 446) and occurs with more different nouns. *Drinkbaar water* accounts for more than half of the tokens of *drinkbaar*, but no noun type has more than 32 occurrences after *eetbaar*.

In a purely analogical account, we would dispense with (6) and take (5) as the result of analogy from (12). In a more moderate view, we can hypothesize that the formation of (5) by the rule in (6) is facilitated by the existence of (12) in the speaker's mental lexicon. In order to assess the contribution of analogy, it is necessary to consider also non-productive rules, such as the ones relating the words in (13).

(13) a. long   length
      b. strong   strength

Marchand (1969: 349) qualifies the suffix *-th* as a "suffix with a few coinages of doubtful currency". It is not *disponible* for the formation of new nouns, the *rentabilité* is extremely low, with only few attested formations, and the *régularité* is reduced by the vowel change observed in (13). Nevertheless, the analogy can play a role in the structure of the mental lexicon at the level of (10b) and contribute to priming as a source of anticipation.

Kiparsky (1974) criticizes the proposal to use analogy as an alternative to word formation rules by pointing to such cases as (14).

(14) a. ear   hear
      b. eye   *heye

The point of the example in (14) is that it demonstrates that analogy cannot explain the existence of a form. If it could, it would also predict *heye* in the sense of 'see'. However, what analogy does in (13) is not the formation of a new word, but the organization of the mental lexicon. This task does not imply the formation of *heye*, because it only organizes words that are already in the mental lexicon. We should now turn to the well-known example of analogy in (15).

(15) a. ham   hamburger

b. cheese   cheeseburger

In (15) we have a case of a new formation, *cheeseburger*, which can only be explained on the basis of an analogy. This raises the question of how (15) relates to (13) and (14). The difference between (14) and (15) is that *cheeseburger* was formed and **heye* not. The occurrence of *cheeseburger* demonstrates that analogy can be used on its own in the formation of a new word. The analogy in (15) is an alternative to the application of a word formation rule, which means that analogy works within the same context. Also in the case of *cheeseburger*, the starting point was a concept to be named and the outcome is subject to onomasiological coercion. In (14), the non-formation of **heye* can be explained by the lack of any need to name a new concept.

The difference between the situation in (13) and in (15) is that in the former case there is a historical word formation rule at work. According to Marchand (1969: 349), the rule applying *-th* was "[p]roductive in Old English and Middle English". This means that the rule is part of the etymology of *length* and *strength*. In ten Hacken (2018), I outline an interpretation of etymological information in dictionaries. Words exist in a speaker's mental lexicon. By their use, the speaker passes them on to others. Basically, an etymology gives the information about likely motivations at points in this chain of transmission between speakers where the transfer results in a word that is different enough to attract attention. That is to say, we highlight points in the historical chain of transmission between speakers where the word in one speaker's mental lexicon is noticeably different from the corresponding word in an earlier speaker's mental lexicon or where no obviously corresponding word can be found.

The starting point of the etymology of a word such as *strength* is a naming act. Here a word formation rule was used in the function of (10a). Analogy as in (13) may have played a role in a way similar to the analogy between (5) and (12). For a modern speaker, the rule no longer plays the same role in (13). By contrast, when *cheeseburger* was formed, there was no word formation rule that could play a role in its formation. According to the entry in OED (2000–2020), *cheeseburger* was first attested "c1930". A comparison with other entries suggests that it was the first formation of this kind. This means that in the original naming as in (10a), no word formation rule was involved.

On the basis of these examples, we can characterize the role of analogy in relation to productive (in the sense of *disponible*) word formation rules as follows. Both analogy and word formation can be used for naming new concepts. Word formation is a rule component that has this as its central function. Both analogy and word formation can be used to organize the structure of entries in the lexicon. The rules in word formation do this much more explicitly. Predictions are only made by word formation rules, not by analogy. These predictions concern both the form and the meaning of expressions, but the meaning is ultimately determined by onomasiological coercion. Priming is influenced both by word formation rules and by analogy, because priming depends on the connections between entries in the lexicon. This means that both word formation rules and analogy have an influence on anticipation of the first type. The rule-based nature of word formation makes this influence more explicit. This explicitness makes it easier to characterize and recognize the contribution to anticipation by word formation rules.

7. Conclusion

This paper started with the question of the interaction between productivity and anticipation. As productivity is a property of rules and anticipation a property of language processing, this interaction is indirect. For the sake of concreteness, I presented Jackendoff's (2002) Parallel Architecture in Fig. 1 as the general framework in which language processing is studied. In PA, language processing means building up a representation with linked phonological, syntactic and conceptual structures for an expression.

As a first step in the exploration of the interaction, I distinguished two places in the language processing chain where anticipation is called for. One is also known as *priming* and concerns the organization of the search in the mental lexicon. The question here is which entries to consider first. The other type of anticipation concerns the expansion of a partial representation. Here the question is how the partially specified representation guides the search for further specification.

As a next step, I considered the notion of *productivity* and its relation to rules. In the relevant sense, a rule is a generalization rather than a prescription. A rule does not say how we should behave but explains observations. At the same time, a rule differs from laws in physics in the sense that a rule generates an expression. Although the productivity of the rules of syntax is historically one of the central inspirations underlying generative grammar, the discussion of productivity focuses on word formation rules.

Then, I presented and discussed two approaches to productivity that are directly applicable to word formation. One, by Schultink (1961), takes morphological productivity in a sense that aligns it with Chomsky's syntactic productivity. It uses unintentionality and an unlimited number of rule applications as the criteria for productivity. The second approach, by Corbin (1987), distinguishes three types of productivity, labelled *disponibilité*, *rentabilité* and *régularité*. Here *disponibilité* is a property of the competence and the other two concern the application of the rules. For a better account of this opposition, I proposed to introduce a separate word formation component, a proposal defended in more detail in ten Hacken (2019).

Against this background I compared the contribution to anticipation of productive (in the sense of *disponibilité*) word formation rules and analogy. I noted that both have their main impact on the type of anticipation associated with priming. Naming, the active formation of a new word as a name for a new concept, is relatively rare. A much more frequent operation is the interpretation of a new word, i.e. the understanding of a word that is not in the speaker's mental lexicon on the basis of word formation rules or analogy. Both naming and understanding a new word can be followed by the extension of the speaker's mental lexicon. Naming is subject to onomasiological coercion, i.e. the meaning of a new word is determined ultimately by the concept to be named, not (entirely) by the process producing the name. New entries in the mental lexicon change the infrastructure for priming. Compared to analogy, productive word formation rules do so in a much more regulated and predictable way, because they are rules. The *disponibilité* of a word formation rule is a necessary condition for it to be perceived as a rule rather than just a generalization. The *rentabilité* and the *régularité* strengthen the anticipatory force of a word formation rule, because they increase its prominence and its predictive value.

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