

TBTA Tutorial Lesson 7: Word Morphophonemic Rules and Grammar Tools

(video: [TBTA-7A Word Morphophonemic Rules](#))

(video: [TBTA-7B Grammar Tools](#))

7.0 Introduction

In the previous lessons you entered several morphophonemic rules in the target lexicon. Those rules performed morphophonemic operations such as changing *bush+s* to *bush+es* and *church+s* to *church+es*, and they also made spelling changes such as *city+s* to *citi+es*, etc. All of those rules were lexical spellout rules because they operated in the lexicon. However, you may have noticed that the spellout rules in the grammar are also capable of performing those same operations. Grammar spellout rules are able to perform morphophonemic operations on words that are built by the grammar spellout rules. The morphophonemic rules that you write in either the lexicon or in the grammar always operate across morpheme boundaries; in other words, they always operate within a single word. In this lesson we're going to look at word morphophonemic rules. Word morphophonemic rules perform the exact same types of operations as the spellout morphophonemic rules, but word morphophonemic rules operate across word boundaries rather than across morpheme boundaries. Word morphophonemic rules can be executed only after the phrase structure rules have placed all of the words in their proper sequence. Therefore word morphophonemic rules are at the end of the generation process. English requires only two word morphophonemic rules: 1) change the Indefinite Article *a* to *an* when the next word begins with a vowel (e.g., *John ate an apple.*), and 2) change the clitic 's to ' when the preceding word ends with an *s* (e.g., *Jesus' disciples*) (remember that TBTA considers clitics to be words that attach to other words). In this lesson we'll learn how to write word morphophonemic rules, and we'll also look at several tools that have been added to TBTA to make your grammar development easier.

7.1 Word Morphophonemic Rules

Let's begin by writing the first word morphophonemic rule described above: changing *a* to *an* when the next word begins with a vowel. Open Grammar Wizard and double click the first word morphophonemic rule template 'Word Morphophonemic Rule: change end of.' You'll then see a new prompting box with all of the standard word syntactic categories and the user defined syntactic categories from your spellout rules. Double click on 'Noun – Article' because we want this rule to apply to the indefinite article *a*. For the End of the Word, enter **a** and push the Tab key. For the New End of Word, enter **an** and push the Tab key. For the Beginning of the Next Word, enter **a,e,i,o,u** without any spaces, and then push the Tab key. You'll then see a word morphophonemic rule. As always we

need to supply a group name, so enter a new group called Articles. For the grammar topic, select Participant Tracking because articles are always associated with participant tracking. Since our spellout rules have entered several different articles (e.g., *a*, *the*, *which*, etc.), we need to specify that this morphophonemic rule should only apply to the article *a*. To do this, click the button labeled Trigger Words, and in the dropdown of the resulting dialog, select *a* and click OK. Your new rule should look like the one shown below in Figure 7-1.

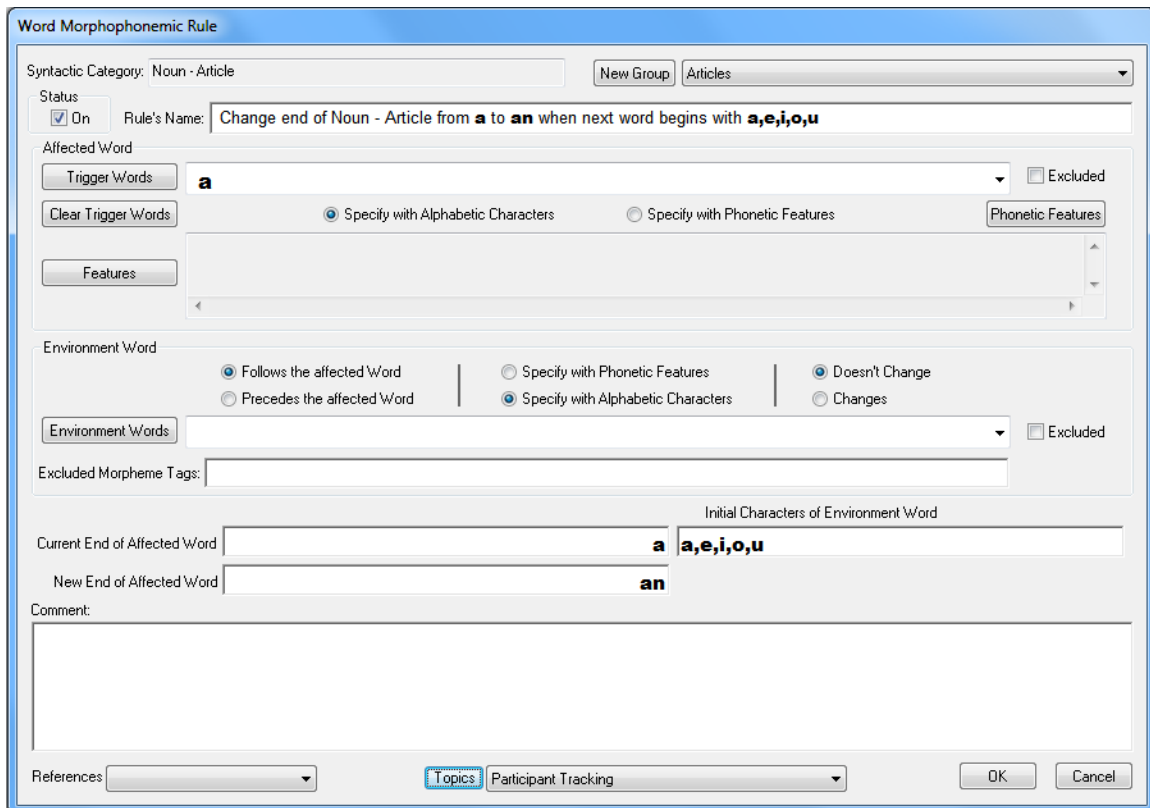


Figure 7-1. Word Morphophonemic Rule for Indefinite Article

To test this rule, go to Luke 1:11. This verse includes the concept ANGEL and it's tagged as First Mention and Singular. Link ANGEL to *angel*, but leave the other concepts unlinked. Push the Generate button and you'll see that the first sentence begins with *An angel* ... If you rest your cursor on *an* in the large window, you'll see that it was changed from *a* to *an* by the rule you just built. Right click on *an* in the large window, and select the menu option Display List of Rules that applied during Generation Process. You'll see a dialog listing all of those rules.

Let's change the word morphophonemic rule we just wrote so that it uses phonetic features rather than alphabetic characters. In the dialog listing all of the rules, double click on Word Morphophonemic in the Type of Rule column. You'll see your rule again. Right now your rule is using alphabetic characters to describe both the affected word (i.e., *a*) and the environment word (in this case *angel*). Sometimes it's more appropriate to describe one or both of the words

with phonetic features. Look near the middle of the rule and you'll see a frame entitled Environment Word. In that frame you'll see an option labeled Specify with Phonetic Features. Select that option and you'll see the text box with *a,e,i,o,u* changed to a grid with five cells. Those five cells represent the first five characters of the next word. Click on the left most cell in the grid and you'll see a dialog listing all of the phonetic features you've defined for the characters in your alphabet. Under the feature Type select Vowel and click OK. You'll then see a V appear in that left cell, and if you rest your cursor on that cell, the popup will tell you that that character must be a vowel. Your new rule should look like the one shown below in Figure 7-2.

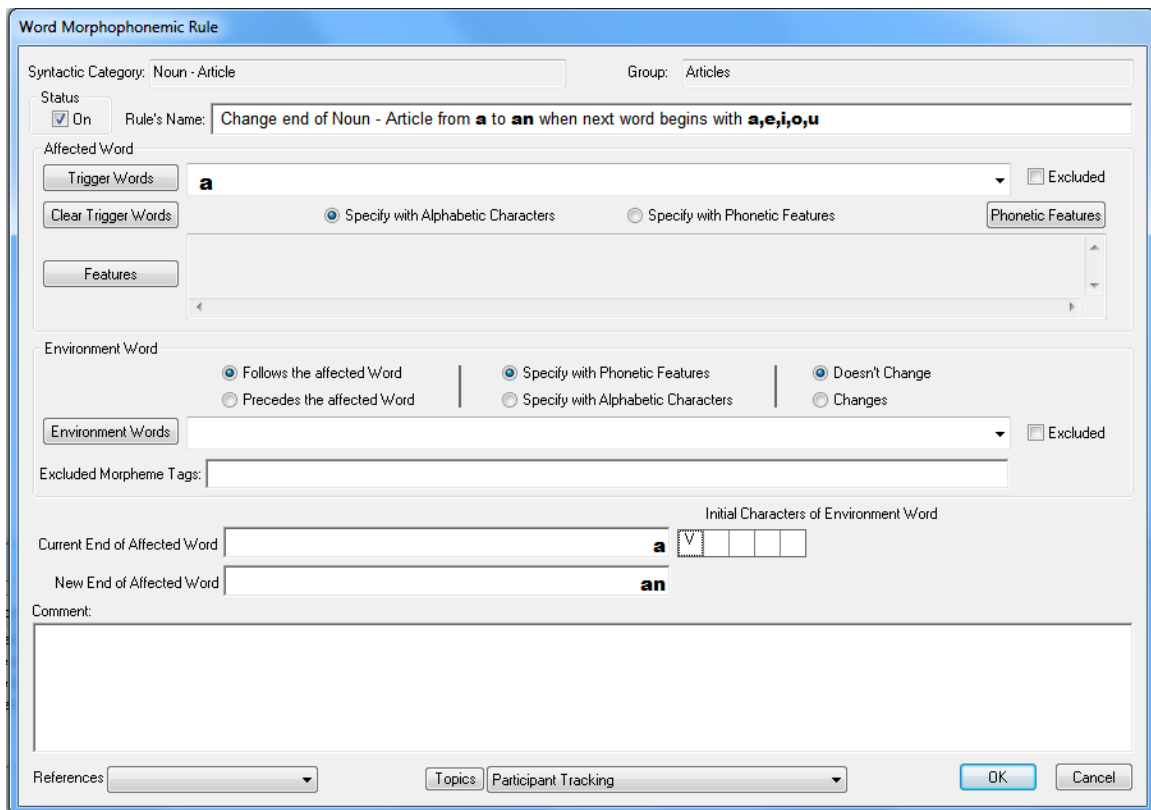


Figure 7-2. Word Morphophonemic Rule with Phonetic Features

Save this rule and generate the verse again. You should get the same results. Just for fun, edit this rule again and set the phonetic features of the second character in the environment word to not a nasal (remember that right clicking on a checkbox specifies 'not', and you'll see a red frame around the checkbox). Generate the verse again and you'll see that this rule doesn't apply anymore because the second character in *angel* is a nasal.

There may be times when you'll want to add new phonetic features or modify the existing phonetic features. If this is the case, go to Ontology and Lexicon, Lexicon, Nouns, and click the Setup button in the upper left corner. Click on the 'Target Alphabetizing Character Sequence' button, and you'll see a dialog with the alphabet you've entered. In the lower left corner is a button labeled Phonetic Features. Click on that button and you'll see the Phonetic

Features dialog. This dialog contains all of the characters that you've entered into your alphabet. At the bottom there's a button labeled New Feature. Click on that button and you'll be prompted to enter the name of a new phonetic feature. Phonetic features are identical to the features that you defined for your target words in the lexicon, except phonetic features apply to alphabetic characters rather than target words. You are able to define any phonetic features that are relevant to your language.

Just for the sake of illustration, let's write a word morphophonemic rule that applies to articles that end with a vowel and precede words that begin with a nasal. In particular, we'll make this rule delete the final vowel of the article. So this rule will change something like *the man* to *th man*. Begin by opening Grammar Wizard and selecting the first word morphophonemic template. When prompted to select the syntactic category, scroll down and select 'Noun – Article'. We're going to use phonetic features for this rule, but Grammar Wizard only deals with alphabetic characters. Therefore we'll write this rule in Grammar Wizard using alphabetic characters, but then we'll change the rule to use phonetic features. For the 'End of Word', enter **e**. For the 'New End of Word', don't enter anything because we want the *e* to be deleted; so just push the Tab key. For the 'Beginning of Next Word', enter **m**, and push the Tab key. This new rule will delete the final *e* from any article if the article is followed by a word that begins with *m*. To convert this rule so that it uses phonetic features, click the Specify with Phonetic Features option in the Affected Word frame. You'll then see the two boxes representing the affected word be changed to grids, each with five cells. These five cells represent the last five characters of the article. Click on the right most cell in the 'Current End of Affected Word' grid and you'll see the phonetic features. Specify Vowel and click OK. Click in the right most cell of the 'New End of Affected Word' grid, and you'll see the phonetic features dialog. This time there's a check box at the top labeled 'Delete Character'. This check box will appear whenever you're specifying the output phonetic features. Check this box and close the features dialog. You'll see an 'X' appear in that cell, and if you rest the cursor on that cell, the popup will indicate that that character will be deleted. To specify the environment word with phonetic features, click on the option labeled 'Specify with Phonetic Features' in the 'Environment Word' frame. Specify that the first character of the environment word must be a bilabial nasal. Your new rule should look like the one shown below in Figure 7-3.

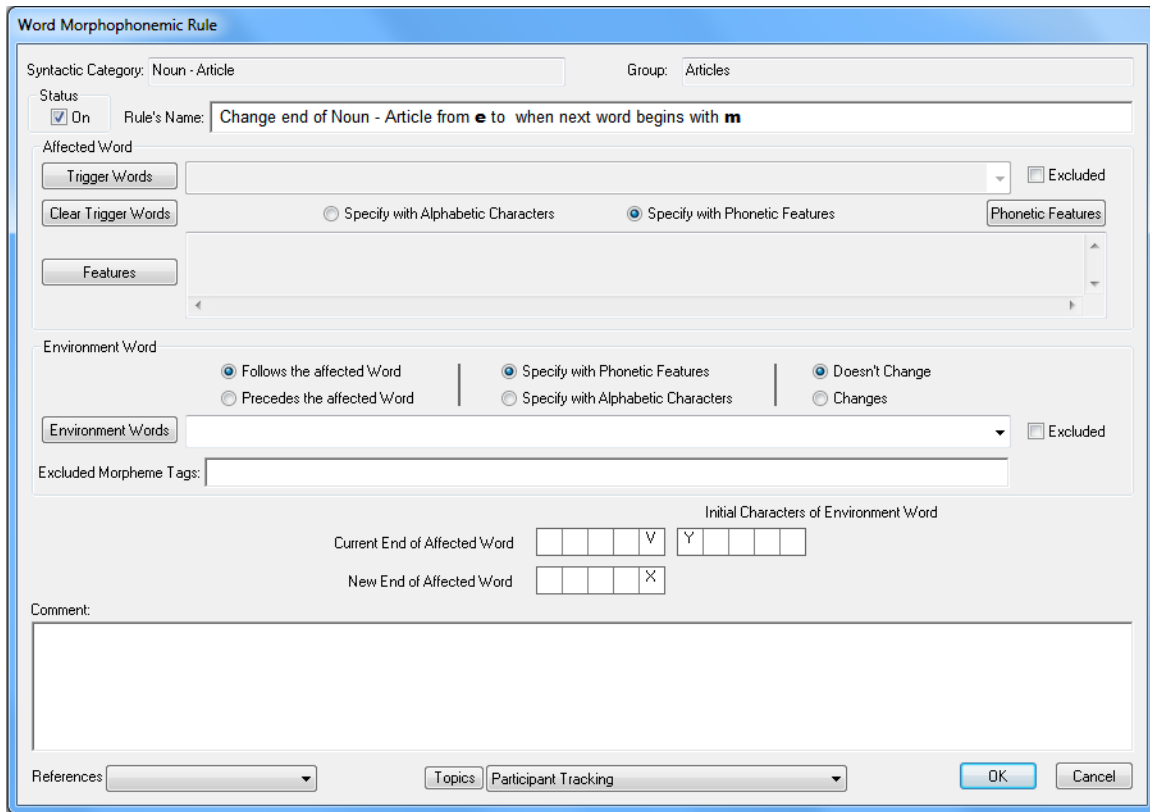


Figure 7-3. Word Morphophonemic Rule that deletes a Final Vowel

Test this rule with Nouns 1:3. You should see *Th man walked*. If you rest the cursor on *th* in the large window, the popup will show you that your new rule changed *the* to *th*, just as you specified.

7.2 Grammar Development Tools

As you develop the lexicon and grammar for your target language, the grammar will inevitably become quite complex. You will eventually have hundreds of rules in your grammar. As you develop your grammar over a period of months, perhaps years, you will occasionally forget which rules are intended to accomplish certain purposes. In order to help you develop your grammar, several tools have been added to TBTA. Five of these tools will be described in this tutorial: 1) Grammar Spy, 2) Grammar Search, 3) Grammar Library, 4) Other Grammars, and 5) Export Grammar.

7.2.1 Grammar Spy

Grammar Spy is a tool that will let you watch your grammar being executed step by step. There will certainly be occasions when rules in your grammar don't operate in the way that you'd intended. A particular rule may apply in a situation where you didn't want it to apply, or a rule may not apply in a situation where you do want it to apply. In order to watch your grammar being executed step by step, you should use Grammar Spy. Grammar Spy will show you every decision being

made by the grammar and every change that is being performed. To invoke Grammar Spy, all you do is click once on a rule's name in the grammar tree. You'll see that rule's name appear in the lower text box below the grammar tree. Then push the Generate button. All of the rules in your grammar that precede the selected rule will be executed. Then, when the system is ready to execute the rule you've selected, you'll see a new dialog appear at the bottom of the screen. This new dialog will tell you exactly what the grammar execution routine is ready to do. Read the text in the dialog, and then click the 'Execute Next Step' button. When you push the 'Execute Next Step' button, one more step of your grammar will be executed, and the new details will be displayed. Continue pushing the 'Execute Next Step' button, and read the details in the dialog. After you've determined which part of a rule is not performing the way you'd intended, you may click either the 'Finish Generation' button or the 'Terminate Generation' button. Invoke Grammar Spy on a particular rule in each of the rule types and watch the generation process step by step. The contents of Grammar Spy's dialog will change according to the type of rule being executed. For example, expand the Feature Copying Rules node and click on the name of your rule that copies Person and Number from nouns in Participant NPs to the verb. You'll see the name of that rule appear immediately below the grammar tree. Now push the Generate button. A few seconds later you'll see Grammar Spy's dialog appear as shown below in Figure 7-4.

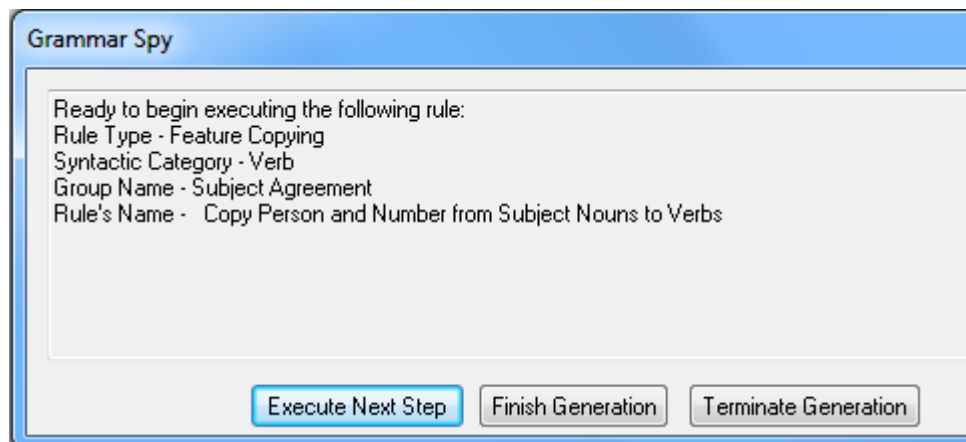


Figure 7-4. Grammar Spy ready to execute a Feature Copying Rule

Push the 'Execute Next Step' button a few times and read each message. You'll see that it's searching for a verb in order to copy features to that verb. Continue pushing the 'Execute Next Step' button and read the messages. Eventually after the rule has copied the features, click the 'Finish Generation' button. Repeat this process with a spellout rule, a clitic rule, a constituent movement rule, a phrase structure rule and a word morphophonemic rule.

When you invoke Grammar Spy on a particular rule, the system will execute all of the rules that precede the selected rule, and then show you the Grammar Spy details when it is ready to begin executing the rule you've selected. After you've selected a rule, you may also right click on a word, phrase or clause in the semantic representation and choose the menu option Invoke Grammar Spy on

this Word. Then the system will wait to show you the Grammar Spy dialog until it is ready to perform the selected rule on the selected word. Specifying both the rule and the word will save you some time walking through your grammar with Grammar Spy.

After you've walked through a verse with Grammar Spy, you may want to generate the verse without invoking Grammar Spy. To clear the previously selected rule from Grammar Spy, just click on any text in the grammar tree that isn't a rule name. So you can click on a group name, a syntactic category, or a rule type. You'll then see that the previously selected rule's name is cleared from the lower text box below the grammar tree. When that text box is clear, you'll be able to generate the verse without stopping for Grammar Spy.

7.2.2 Grammar Search

As you're developing your grammar, there may be times when you want to see all of the rules that have been assigned to a particular grammar topic. Or you may want to see all of the rules that use a particular feature value. You may want to see all of the rules that include a particular source concept or target word. There might be a time when you want to see all of the rules that add a morpheme with a particular tag. A utility has been added to TBTA that will help you search through your grammar. To search through your grammar, click on the button labeled Search Grammar (directly to the right of the Grammar Wizard button). You'll see a new dialog with a dropdown at the top. Open the dropdown and you'll see all of the types of searches you may perform. After selecting a type of search, you'll be asked to specify the details of what you want to search for. Go ahead and perform several searches through your grammar. Be sure to try at least one example of each type of search. By far the most helpful grammar search is the first one – Grammar Topics. When you select this search, you'll see another dropdown listing all of the grammar topics you've defined. Select one of them and then click the Search button. You'll then see a new dialog listing all of the rules that have been assigned to that topic. You may view or edit any of those rules by double clicking on the type of rule in the leftmost column.

7.2.3 Grammar Library

A library of grammar rules is included with TBTA in order to simplify the process of building your grammar. To see this library, go to the Lexicon and Grammar Development screen, and check the box in the lower right corner labeled Grammar Library. When you start a new language project, you should check this library to see if there are any rules that are pertinent to your language. For example, go to Noun Phrases 1:9 which produces *John walked with Mary*. Suppose your target language uses conjoined subject NPs rather than comitative NPs (i.e., your language says the equivalent of *John and Mary walked* rather than *John walked with Mary*). If that's the case, open the Grammar Library, and then open the node called Common Transfer Rules. The first rule in that group is named Convert Comitative NPs to Conjoined Agent NPs. You can look at that

rule by double clicking on its name, and you'll see how it converts NPs containing WITH-A to conjoined agent NPs. If that rule is appropriate for your language, then open the node called Complex Concept Insertion Rules and Library Rules at the top of the grammar tree (close the library rule if it's still open), and you'll see a group called Common Transfer Rules Copied from the Library. You can now drag the rule from the library to this group. After you've completed the drag process, you'll immediately see the semantic representation for Noun Phrases 1:9 change due to the execution of the library rule (you don't need to click the Generate button).

For another example, suppose that your target language doesn't have an equivalent for the concept UNTIL. UNTIL is used in multiple event modifying propositions as in Clauses 1:71 which produces *John read this book until Mary started reading that book*. Suppose your target language needs to reconstruct this proposition so that it becomes something like *When Mary started reading that book, John stopped reading this book*. If that's the case, then you can simply drag the library rule called "Convert 'until' adverbials to 'when' adverbials, Set matrix verb to Cessative Aspect" to the group in the grammar tree called Common Transfer Rules Copied from the Library. After you've dropped that rule into your grammar, you'll immediately see the semantic representation of Clauses 1:71 restructured according to that rule (you don't need to click the Generate button).

When you start a new language project, you should go through the Grammar Library and examine each rule to determine whether or not it's appropriate for your language. The list of rules in the library is constantly being updated, so the rules can't be described here.

7.2.4 Other Grammars

When developing your grammar, it is often helpful to see how a particular issue was handled in another grammar. For example, you might want to see how the movement issue for questions was handled in the English grammar supplied with TBTA. You can easily examine the grammars of other languages by clicking the Other Grammars button in the lower right corner of the Lexicon and Grammar Development screen (close the Grammar Library by unchecking the box labeled 'Show Grammar Library'). When you click that button, you'll see a new dialog that contains a grammar tree. There's a dropdown at the top of the dialog indicating which grammar is currently loaded into the tree. Select English in the dropdown, and then open the Movement Rules node. You'll see several groups; open the Interrogatives node. In that group there will be a single rule, so open it. You'll then see a movement rule that has sixteen structures. You can scroll through the structures and see that each one performs a particular movement. You can't edit the rules that are in another grammar from this dialog, but you can quickly see the rules and how they handle particular issues.

7.2.5 Export Grammar

As you're developing your grammar, you may occasionally want to see the entire grammar organized by grammar topics. You can export your grammar to either an HTML file or a plain text file by clicking the button labeled Export Grammar in the lower right corner of the Lexicon and Grammar Development screen. You'll then see a small dialog with several options. After specifying the options you want, click the OK button and you'll then be prompted to specify where you want the file to be saved. After you've specified a location, TBTA will export your grammar. You can then open the file and see your grammatical rules. This file can serve as the beginning of a grammar sketch for your language.

Note that if you choose the option to organize the exported grammar by grammar topics (the default option), then only rules that have been assigned to a grammar topic can be exported. This is one of the reasons why it is important to assign each of your rules to one or more grammar topics.

7.3 Conclusions

This lesson introduced you to word morphophonemic rules and five grammar tools. Word morphophonemic rules perform morphophonemic operations across word boundaries rather than across morpheme boundaries as we saw in the spellout rules. For this reason, word morphophonemic rules must be executed after the phrase structure rules have ordered all of the constituents appropriately.

Grammar Spy will become extremely helpful to you as your grammar becomes increasingly complex. You can watch each rule as it is being executed, and Grammar Spy will explain why the grammar execution module is making each decision.