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INFERENTIAL-REALIZATIONAL MORPHOLOGY AND AFFIX ORDERING: EVIDENCE FROM THE AGREEMENT PATTERNS OF BASQUE AUXILIARY VERBS

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THESIS

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ABSTRACT OF THESIS

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“No aspect of Basque linguistics has received more attention over the years than the morphology of the verb.” (Trask 1981:1)

The current study examines the complex morphological agreement patterns found in the Basque auxiliary verb system as a case in point for discussion of theoretical approaches to inflectional morphology. The traditional syntax-driven treatment of these auxiliaries is contrasted with an inferential, morphology-driven analysis within the Paradigm Function Morphology framework. Additionally, a computational implementation of the current analysis using the DATR lexical knowledge representation language is discussed.

KEYWORDS: Inflectional Morphology, Basque Language, Auxiliary Verbs, Agreement and Alignment, Paradigm Function Morphology

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1 INTRODUCTION The Basque language, known locally as Euskara, is spoken by around 660,000 people, most of whom inhabit an area on both sides of the border between Spain and France along the Atlantic coast and Pyrenees mountains. This region, commonly referred to as the Basque Country, is generally divided into seven provinces in three major regions. Four of these provinces lie on the Spanish side of the border; Bizkaia, Gípuzkoa, and Araba make up the Basque Autonomous Region of Spain, and Nafarroa (sometimes referred to as Navarre) lies within the geopolitical boundary of Spain, but exists as an autonomous region. Lapurdi, Nafarroa Beherea, and Zuberoa lie within the French region of Pyrénées-Atlantique. The majority of the speakers of Euskara reside in the Spanish regions of the Basque Country (Trask 1991:1-5). In his descriptive grammar of the Basque language, Saltarelli (1988) notes that a lack of unified political and geographical identity among the various provinces has given rise to varied dialects across the region, though a somewhat standardized literary form (Batua) has arisen in order to facilitate communication across the region.

Perhaps the most interesting aspect of the Basque language stems from the fact that it appears to be a language isolate; that it does not appear to have any relationship with any of the surrounding regional languages (or any known language for that matter). Although there are numerous examples of attempts to locate Basque within the genealogy of various language families, none seem to hold up under scrutiny. As Trask (1991:35) describes, "Basque is a genetically isolated language; there is not the slightest shred of evidence that it is related to any other living language".

Linguistic research on Basque has been conducted for over a century, spanning nearly every subfield of the science and including the application of a multitude of theoretical frameworks. Early work on the language centered on solving the mystery of Basque's origins within the genealogy of Europe's languages (cf. von Humboldt 1821), a tradition that has continued to the present (cf. Forni 2013). For a thorough discussion of a number of theories linking Basque to language families around the world, see Trask (1997). Another major focus of Basque studies combines phonology and historical linguistics in an endeavor to reconstruct proto-Basque syllables, roots, and word forms (cf. Michelina 1977; Lakarra 1995). Historical linguistic research on the language has also extended to syntax in recent years (cf. Uriagereka 2011). A third area of interest is the complex morphology of Basque, a detailed overview of which is offered in §2. In §3, modern theoretical approaches to inflectional morphology are outlined, with attention given to realizational frameworks. Much of the current work on Basque auxiliaries follows the lexical-realizational model, while the current study proposes the preference of inferential-realizational theory. §4 provides a thumbnail sketch of the Basque language, detailing the alignment, case marking, agreement, and other phenomena which are relevant to the current study of Basque auxiliaries. §5 details approaches to analyzing the agreement patterns illustrated in §4 within the Paradigm Function Morphology (Stump 2001) framework. In §6, a computational model of the Paradigm Function Morphology analysis utilizing the DATR programming language is outlined, with attention to specific phenomena that the analysis is meant to reflect. Finally, §7 presents general conclusions and a discussion of further avenues of research. Subsequent appendices provide a working set of paradigms for the indicative mood forms of Basque auxiliaries and the full DATR model discussed in §6.

2 BASQUE VERBAL MORPHOLOGY From his 1981 treatise on the Basque verb, Trask notes, "No aspect of Basque linguistics has received more attention over the years than the morphology of the verb" (1981:1). Studies of the verbal morphology of Basque began in the middle of the 19th century, especially in the research of Bonaparte (1869), who provided a thorough analysis of Basque verb forms from a wide variety of dialects. While Bonaparte's theories of the structure of verb forms and dialect boundaries have been largely refuted over the decades, his work lives on mostly through the extensive sets of verb paradigms that have continued to provide data sets for analyses to this day. Schuchardt (1893) advanced one of the most popular early theories, that all Basque verbs were inherently passive as evidenced by the complex and unusual system of agreement patterns they demonstrated. While Schuchardt's theory would be later proven to be unsubstantiated, it drew focus to the issue of alignment in Basque, which would later be shown to be ergative-absolutive in nature rather than inherently passive. Another notable reference for students of Basque verbal morphology is Lafon's (1944) book on the subject. This work, while highly historical in orientation, has endured due to the fact that many of his analyses are still accepted in the current understanding of Basque verbs. One of Lafon's most important contributions is his description of the fact that many syntactically intransitive verbs take transitive morphology. While he was ultimately unable to discern an acceptable analysis of this fact, Lafon's work indeed paved the way for future studies of Basque verbal inflection. Other notable general works on Basque verbal morphology include Trask (1977; 1981) and Etxepare (2003), among others.

2.1 ALLOCUTIVE AGREEMENT One of the most typologically unique features of Basque morphosyntax is the presence of overt markers of familiarity with the addressee of an utterance, specifically when that person is not an argument of the verb itself. Termed allocutive, this agreement indexes the sex (male or female) of a familiar addressee with an affix on the auxiliary verb. There exist two important references for analysis of this allocutive phenomenon. Oyharçabal's (1993) generative approach focuses on syntactic patterns and parameters and the interaction of morphology and syntax. Specifically, he argues that allocutive agreement is a covert syntactic phenomenon that is pronounced in the morphology. Adaskina and Grashchenkov (2009) provide a descriptive account of allocutive agreement as well as analyses of its relationship with both the syntax and morphology of the language. In addition, the authors advance several theories related to the morphophonological processes that are triggered by the concatenation of the allocutive agreement morpheme with the surrounding agreement affixes. Finally, this work introduces and discusses the innovated gloss for the allocutive agreement marker (BAM.M/F 'Basque Allocutive Marker Female/Male'). This phenomenon is typologically unique; to this point, only the Cushitic language Beja has been described as possibly having allocutive agreement in addition to Basque (cf. Weninger 2011).

3 INFLECTIONAL MORPHOLOGY In any theoretical work involving the morphology of inflection and affixation, it is necessary to outline some of the major competing theories of how inflected word forms are composed and encoded. Stump (2001: 1-30) presents a thorough overview of these theories, a brief discussion of which is offered here. Stump describes two types of distinctions that can be seen in theories of inflection, one between *lexical* and *inferential* analyses, and the other between *incremental* and *realizational*. According to Stump, *incremental* processes involve the idea that an affix carries with it a set of properties (i.e. 3rd person plural) that are added to the inflected word by virtue of affixation. This contrasts with the *realizational* analysis, which holds that the association of a set of properties with a root governs the linking of that root with the appropriate affix. In *lexical* theories of inflectional morphology, affixes and their encoded property sets are stored in the lexicon alongside word forms. This stands in opposition to *inferential* approaches, which attribute inflected word formation to mathematical formulae/functions that govern a series of rules which decide how and where affixation should apply to a root in order to produce its inflectional paradigm. At the intersection of these two distinctions, four major theoretical frameworks emerge: *1) lexical-incremental, 2) inferential-incremental*, *3) lexical-realizational*, *4) inferential-realizational*. Stump goes on to describe how each of these has been articulated in the literature.

3.1 LEXICAL-INCREMENTAL INFLECTION Stump (2001:2) identifies Lieber (1992) as an example of the lexical and incremental version of the story. According to this theory, both roots and affixes are featured separately in the lexicon, where they are specified not only for morphosyntactic properties (i.e. whether they are stems or affixes; properties like 3rd person, singular, etc.) but also restrictions on how they can combine in a licit way. In this type of analysis, affixes would then have a specification that denotes whether they are a prefix or a suffix and what kind of root they can attach to.

3.2 INFERENTIAL-INCREMENTAL INFLECTION Steele's (1995; in Stump 2001:2-3) Articulated Morphology is an example of the inferential and incremental approach. In this type of theory, a set of rules in the morphology of a language defines how affixes that encode morphosyntactic properties are applied to bare, uninflected stems. Furthermore, this theory indicates that the specific morphosyntactic properties encoded by an affix are added to the inflected stem by virtue of affixation.

3.3 LEXICAL-REALIZATIONAL INFLECTION In terms of current theories of Basque verbal morphology, incremental analyses are somewhat lacking in the literature, therefore the discussion will mainly focus on realizational theories of inflectional morphology. At the intersection of lexical and realizational models lies the theory of Distributed Morphology (cf. Halle and Marantz 1993,1994; Matushansky and Marantz 2013). The Distributed Morphology approach relies on the idea that lexically stipulated affixes are slotted into position in order to pronounce syntactically constructed morphemes. In other words, the syntax creates a set of morphosyntactic properties through a series of processes which are then realized by the selection of the appropriate matching affix from the lexicon.

Lexical-realizational analyses of Basque verbal predication are numerous, growing out of transformational theories of linguistics. One example of this type of treatment is Oyharçabal's (1993) aforementioned analysis of the allocutive phenomenon (see §2.1). Laka (2006) provides another such account of Basque verbal morphology. He argues that the complex system of agreement patterns can be accounted for by positing an inalienable link between the morphology and deep structure syntax. Furthermore, he outlines the role of the lexicon in storing affixes as concrete morphemes inserted in order to pronounce feature sets. Drawing on this approach, Arregi and Nevins (2012) further explains the role of morphotactics and constraints in determining way in which Basque auxiliaries are formed. According to this analysis, the auxiliary, which can be described as a series of agreement clitics affixed to the root, is created when the processes of Head Movement and Cliticization cause the morphosyntactic properties occupying specifier positions to aggregate into a single morphological word. These properties are then pronounced by a postsyntactic process in which lexically specified morphemes are slotted into the correct positions (Arregi and Nevins 2012:4-45). This theory goes on to address issues of variable affix ordering by positing another set of rules that govern movement of affixes based on certain constraints.

3.4 INFERENTIAL-REALIZATIONAL INFLECTION The fourth type of inflectional theory deals with the intersection of rule-based inferential approaches with realizational conceptions of how morphosyntactic properties license the attachment of an affix to a stem. Importantly, theories of this type differ from lexical theories in that while the lexical approach implies a necessary link between morphology and syntax, these theories treat morphology as a separate, autonomous entity. While several such theories have been posited, there are two main approaches to consider here.

Network Morphology (Brown and Hippisley 2012) provides an example of paradigm-based inferential-realizational morphology. Like other inferential-realizational theories, Network Morphology treats morphology as a separate entity within the grammar. In this conception of the structure of inflected words, the overall system is treated as a hierarchy, with defaults that are passed through from the top level through the subsequent nodes. These defaults can then be accepted or overridden, allowing for further specification of certain types of inflected words, specifically irregulars. Additionally, the hierarchical structure of the Network Morphology approach accounts for syncretism by positing multiple levels of inheritance, whereby a node can inherit features from other nodes in the hierarchy. Furthermore, paths within the same node can share realizations as well. In this way, the paradigm of an inflectional system is generated by associating the cells of the paradigm with the morphosyntactic properties they encode. As each word form passes through the model, it draws on the assumptions of the nodes above it, as well as overrides that stipulate irregularities in the system.

Stump (2001) provides a thoughtful examination of the various theories of inflection before articulating a rule-based theory that relies on the concept of a mathematical function that generates the paradigm of an inflected word. Termed Paradigm Function Morphology (PFM), the theory postulates that inflectional systems can be reduced to a series of blocks of rules which realize specific morphemes based on which morphosyntactic properties are associated with the inflected word itself. Furthermore, the order of application of these rule blocks can be defined by a Paradigm Function, a mathematical operation that governs the way in which specific stems and affixes are selected and ordered. In this way, the Paradigm Function generates the each cell of the paradigm of an inflected word. Of particular relevance to the current study is the ability of Paradigm Function Morphology to account for the stem alternations and variable affix ordering apparent in the Basque auxiliary system. Stump's theory argues that the presence of stem alternations provides further support for the fact that morphology is a separate component of the grammar of a language, in that these alternations can be accounted for by rules within the morphology that select a given stem based on the morphosyntactic properties associated with a particular cell in the paradigm. Additionally, the robust yet flexible nature of Paradigm Function Morphology allows for the necessary ability to constrain the proposed morphological rules in a regimented way while admitting the possibility of motivating more complex operations that account for instances of variable affix order, heteroclisis, and defectiveness, among other morphological phenomena. In other words, both stem and affix order variability are accounted for by positing the association of the morphosyntactic properties of a given cell with rules that govern stem selection and affix ordering. This theory also draws on Aronoff's (1994) seminal work, which provides an analysis of stems and inflectional classes as a case in point in arguing against theories that treat morphology as an offshoot of syntax and/or phonology and in favor of treating morphology as an autonomous entity within language.

The preceding overview of both past and contemporary studies of Basque linguistics, combined with the discussion of theories of inflection, is meant to provide a concise definition of the various attitudes and frameworks that shape the current state of the discipline. Especially important is the distinction between lexical and inferential models of inflectional morphology as it pertains to the way affixes are concatenated with the root in the Basque auxiliary system.

4 THE BASQUE LANGUAGE What follows is a thumbnail sketch of the Basque auxiliary verb's inflectional morphology as it relates to stem selection, agreement, and affix ordering. The overwhelming majority of verbs in Basque are periphrastic, consisting of a main verb and an auxiliary. The main verb takes the perfective participle, as opposed to the verbal root, as its citation form. With very few exceptions, predicates are composed of a 'main verb', which carries the semantic meaning (as well as aspectual markers), and an auxiliary verb, which is marked for tense, mood, and agreement with the arguments of the main verb. It should be noted that there are some exceptions to this type of verb matrix construction, although the set of verbs that can inflect without the help of an auxiliary is very small and seems to be characterized by antiquated verb forms from a previous stage in the language's development. This can be evidenced by the fact that some of the verbs in this category only inflect without an auxiliary in certain forms, while others can only stand alone in certain literary contexts (Laka 1996:81). In his 1993 analysis of syntactic processes in Basque, Laka provides the following example of a verb that can inflect synthetically or periphrastically:

(1) a. *ekarri* *n-a-u-zu*
bring 1SG.ABS-PRES-AUX-2FORMAL.ERG
'you(formal) bring me'

b. *n-a-kar-zu*
1SG.ABS-PRES-bring-2FORMAL.ERG
'you(formal) bring me'

In (1), it is clear that the verb *ekar* 'to bring' can inflect both periphrastically with an auxiliary (1a.) and synthetically without an auxiliary (1b.), which potentially speaks to the ever-evolving nature of the Basque verbal system. Lafon (1944) describes a situation in which a largely synthetic verbal system in the 17th century had mostly been replaced by periphrastic forms by the turn of the 20th century. Laka (1996) describes the modern language as having no more than twenty verbs that can inflect synthetically, though it is common to see these verbs in periphrastic constructions as well.

4.1 CASE MARKING AND ALIGNMENT Basque has an ergative-absolutive case marking system, both in terms of the way subjects and objects are marked based on the transitivity of the verbs they coincide with and how these alignment relationships are marked on the verb. Specifically, the subject of an intransitive verb and the direct object of a transitive verb are in the absolutive case (which is unmarked in Basque), while the agent of a transitive verb is in the ergative case (which is marked with the suffix -*k*). Auxiliary verbs also reflect this ergative-absolutive argument system through a system of agreement markers that are affixed to the auxiliary root. This can be demonstrated by looking at the following examples adapted from Laka (1996:9):

(2) a. *umea-Ø kalean erori d-a-Ø*
child-ABS street fall 3SG.ABS-PRES-AUX
'the child falls in the street'

b. *ni-k gizona-Ø ikusi d-u-t*
I-ERG man-ABS seen 3SG.ABS-AUX-1SG.ERG
'I see the man'

In (2a.), the intransitive verb *erori* 'to fall' requires that the subject *umea* 'child' be in the absolutive case (which is unmarked in Basque). In (2b.), the argument structure of the transitive verb *ikusi* 'to see' requires a subject and a direct object. Here, the agent *emakumea* 'the woman' is marked with the suffix -*k* to label it as being in the ergative case, while the object *gizona* 'the man' is in the absolutive case (which is again unmarked). This administration of the ergative-absolutive case marking system is not limited to Basque nouns; verbs also feature a complex system of agreement, as illustrated in (2). Note that in the auxiliary verbs in both examples in (2), the affix *d-* marks agreement with the 3rd person singular absolutive argument. In (2b.), agreement with the 1st person singular ergative argument is marked on the auxiliary with the affix *-t*.

Because the argument structure of the matrix verb plays an important role in the Basque case-marking system, it is necessary to be able to distinguish between transitive and intransitive verbs. In Basque, although the transitivity can be ascertained from looking at the case-marking on a verb's arguments, it is relevant to discuss the other ways that valence can be identified. In addition to the number and types of arguments surrounding a verb, transitivity can be judged based on the types of auxiliaries the perfective participle joins with in order to create the verb matrix. Outside of these contextual identifiers, there is no overt morphology on the perfective participle 'stems' that encodes for valence (Laka 1996:76).

4.2 INDICATIVE CONSTRUCTIONS In the indicative mood, intransitive auxiliary roots are derived from *izan* 'to be'. Transitive roots are derived from **edun* 'to have', which does not exist in the current state of the language in its participle citation form, but rather is a reconstruction based on the root *-(d)u-*. This reconstructed form is somewhat defective in its realization as an auxiliary root, with its gaps suppletively filled by *izan* 'to be' in most dialects. As with many languages, the verbs meaning 'to be' and 'to have' in Basque are highly defective and irregular. Note that the root of the auxiliary in (1a) is *-a-*, which is derived from *izan*. In (1b), the root is *-(du)-* with the *-d-* being elided due to phonological necessity, as it is preceded by the identical morpheme. The scope of the current study focuses on the indicative auxiliaries, despite the ability to express other moods with auxiliaries in Basque, as the indicative paradigm acts as an exemplar for the rest of the system in terms of agreement patterns and paradigm composition.

4.3 SUBJUNCTIVE CONSTRUCTIONS Like the indicative, the subjunctive mood is formed periphrastically, but differs in multiple ways. Unlike indicative constructions, the subjunctive combines the auxiliary with the root form (rather than the participle) of the main verb. In addition, subjunctive auxiliaries differ from their indicative counterparts in terms of the verbs they use to derive their stems. Intransitive subjunctive roots are derived from the reconstructed **edin*, while transitive subjunctive roots are derived from the reconstructed **ezan*. It should be noted again that these reconstructions are based on the roots themselves, and likely refer to an earlier stage in the language where these verbs may have existed in synthetic (non-periphrastic) constructions. Much like their indicative counterparts, these verbs are noticeably irregular and defective as well. The subjunctive is typically used in subordinate clauses that express desires or requests. In this construction, the auxiliary in the embedded clause takes the subjunctive root and features the complementizer suffix -*n* in both present and past tense, with an epenthetic -*e* inserted after a consonant. The subjunctive construction is illustrated in the following example (Saltarelli 1988:237):

(3)	*etor*	*z-a-itez-en*	*nahi*	*d-u-t*
	come	2FORMAL.ABS-PRES-AUX-COMP	want	3SG.ABS-AUX-1SG.ERG
	'I want you(formal) to come'			

Note that the main verb *etor* 'to go' is in its root form, and that the root of the subjunctive auxiliary *zaitezen* is structurally different from the indicative roots in (1) and (2). Furthermore, the auxiliary in the matrix clause *dut* is the same indicative form seen in (2b.).

4.4 IMPERATIVE CONSTRUCTIONS Imperative mood forms are based on the subjunctive mood roots, and follow many of the same patterns as the subjunctive. There are some notable differences that are unique to the imperative construction. For example, the intransitive imperative paradigm lacks cells for first person. By extension, though the transitive imperative paradigm includes cells for first person absolutive (object) agreement, it lacks cells for first person ergative (subject) agreement. In other words, though Basque does not allow commands with first person agents, it does allow commands to feature first person objects, as in (4):

(4) *utz* *n-a-za-zu*
leave 1SG.ABS-PRES-AUX-2SG.FORMAL.ERG
'(You) leave me'

In the example in (4), the root *utz* 'to leave' combines with the imperative auxiliary, which derives its root from **ezan* 'to have', and is inflected to show agreement with its arguments, as well as tense.

Interestingly, though there are third person imperatives, they generally exist in the context of the addressee being socially superior to the speaker (cf. English 'Thy kingdom come'). This seems to be a somewhat antiquated and uncommon use; Saltarelli (1988) notes that third person imperatives are more commonly expressed using subjunctive constructions. Finally, ditransitive constructions (featuring ergative, absolutive, and dative arguments) cannot be expressed in the imperative.

4.5 CONDITIONAL AND POTENTIAL CONSTRUCTIONS Like the imperative, both the conditional and potential moods derive their roots from the subjunctive. The conditional is expressed with a conjunction of protasis and apodosis forms. The protasis features the prefix clitic *ba-* attached to the past tense form of the auxiliary. The resulting apodosis forms feature the potential marker *-(te-)ke*, where the *te-* is elided in some forms due to phonology:

(5)	*bihar*	*euria*	*egingo*	*ba-l-u,*
	tomorrow	rain	make	if-3SG.ERG-AUX
	etxean	*geldituko*	*n-in-tza-teke*	
	house	remain	1SG.ABS-PAST-AUX-POT	

'if it rained tomorrow, I would stay at home'

4.6 ALIGNMENT AND ERGATIVE SPLITS Analyses of languages with ergative-absolutive systems have centered on the strong tendency for these systems deviate from the expected alignment in certain contexts. These deviations, often termed 'splits', occur in different contexts cross-linguistically, typically in relation to specific morphosyntactic properties (i.e. tense, number, etc.). A famous example of split ergativity can be seen in the pronominal inflection of the Australian language Dyirbal. As outlined in Dixon's (1979) typology of ergative languages and splits, first and second person Dyirbal pronouns follow a typical nominative-accusative alignment, while third person pronouns clearly reflect an ergative-absolutive system. Other examples of split ergative case marking systems are numerous; in fact, nearly all so-called ergative languages feature varying degrees of splits in their alignment systems. Interestingly, the Basque morphology exhibits no discernible splits; ergative-absolutive alignment pervades the entirety of the nominal and verbal inflectional systems. In his 1984 examination of ergativity in Basque, Bossong systematically disproves the possibility of splits anywhere in the nominal or verbal morphology. Moreover, he specifically outlines the agreement affix ordering phenomenon that the current study focuses on, demonstrating convincingly that even this seemingly aberrant part of the Basque auxiliary paradigm does not represent a deviation from the ergative-absolutive case marking system.

4.7 ALLOCUTIVE AGREEMENT One of the most interesting features of Basque morphology is that the auxiliary verb can be inflected to contain information (including gender and familiarity to the speaker) about the addressee of an utterance, specifically when that addressee is not an argument of the 'main verb' (cf. §2.1). Adaskina and Grashchenkov (2009:1) illustrate this with the following example sentences (the authors propose an innovated gloss BAM.F/M, which stands for 'Basque Allocutive Marker Female/Male'):

(6) a. *Ataunen jaio n-a-iz*
Ataun born 1SG.ABS-PRES-AUX
'I was born in Ataun'

b. *Ataunen jaio n-a-u-k*
Ataun born 1SG.ABS-PRES-AUX-BAM.M
'I was born in Ataun (male familiar addressee)'

c. *Ataunen jaio n-a-u-n*
Ataun born 1SG.ABS-PRES-AUX-BAM.F
'I was born in Ataun (female familiar addressee)'

In (6), information about the addressee is expressed by the auxiliary if he or she has some relation to the speaker in terms of familiarity. If this socially-based relationship exists, then the appropriate allocutive marker suffix is added onto the end of the auxiliary verb as in (6b.) and (6c.). Note that these allocutive agreement markers are identical to the regular 2nd person singular informal markers for ergative and dative agreement; in a sense, this allocutive agreement acts as a sort of valence-changing morphology, as evidenced by differences in the selection of the appropriate stem for the auxiliaries in (6). Specifically, the root of the auxiliary in (6a.) *iz* is consistent with intransitive verbs, while the root in (6b.) and (6c.) *u* is indicative of a transitive verb (cf. the previous discussion of transitivity and stem selection). It also appears this agreement is limited to singular forms; there is no allocutive agreement for 2nd person plural addressees.

4.8 AGREEMENT IN AUXILIARIES In Basque, the verb is marked to agree with its core arguments in a complex way, depending on a variety of factors including number of core arguments, their syntactic roles (i.e. agent, subject, object, etc.), and the mood and/or tense of the sentence. The variable ordering of these agreement affixes provides an interesting problem for theories of how inflected words are formed. With very few exceptions, predicates in Basque are composed of a 'main verb', which carries the lexical meaning (as well as aspectual markers), and an auxiliary verb, which is marked for tense in addition to being the locus of agreement with the verbal complex's core arguments. These auxiliaries reflect an ergative-absolutive alignment pattern through a series of affixes that agree with the case, person, and number of each core argument present in the sentence. Verbs are also marked to agree with the dative case, which in Basque is assigned as an indirect object, often expressing the semantic role of RECIPIENT. This periphrastic construction is extremely productive, accounting for nearly all instances of verbal predication in Basque.

It is relevant at this point to explain the second person agreement system. In terms of all three case agreement markers (absolutive, dative, and ergative), there is a distinction between second person singular formal and informal. It should also be noted that the 2nd person singular formal agreement marker appears out of place, in the sense that it is traditionally grouped with the other plurals. The explanation for this is that the original 2nd person plural category has undergone a change in meaning, such that it now carries a 2nd person singular formal distinction. In response to this, a new 2nd person plural form was innovated to fill the vacancy (Laka 1996:93-94). Although the semantic content has changed, these 2nd person singular formal forms still behave as plurals in terms of their morphology:

(7) a. *Hi-k* *emakumea-Ø* *ikusi* *d-u-k*
you-ERG woman-ABS seen 3SG.ABS-AUX-2SG.ERG
'You(sg.) have seen the woman'
b. *Zu-k* *emakumea-Ø* *ikusi* *d-u-zu*
you-ERG woman-ABS seen 3SG.ABS-AUX 2SG.FORMAL.ERG
'You(formal) have seen the woman'
c. *Zue-k* *emakumea-Ø* *ikusi* *d-u-zue*
you-ERG woman-ABS seen 3SG.ABS-AUX-2PL.ERG
'You(pl.) have seen the woman'

The examples in (7) demonstrate the result of this reanalysis of the 2nd person agreement system. Note that while the root of the auxiliary stays the same in each of these examples, as it agrees in person and number with the absolutive argument. The telling difference between can be seen in the exponent marking ergative agreement in the examples in (7). Specifically, the similarity between the 2nd person formal (7b.) and 2nd person plural (7c.) ergative suffixes speaks to the fact that the innovated 2nd person plural morphology was simply added to the reanalyzed formal form in order to differentiate between the two. Moreover, the 2nd person plural does not make a distinction based on formality.

The auxiliary is the target of agreement for the predicator's arguments. Traditionally, Basque auxiliary verbs are separated into four classes (cf. Saltarelli 1998; Laka 1996, among others) which are the result of the four logical combinations of ergative, absolutive, and dative arguments; 1) absolutive only, 2) absolutive and dative, 3) absolutive and ergative, 4) absolutive, dative, and ergative. Inflectional realization can be described as the slotting of various affixes into specific affix positions around the root, though the identity of the affix at each position can vary based on the nature of the class the auxiliary belongs to. It should also be noted that while the auxiliary does mark agreement with dative arguments, these datives do not affect the transitivity of the verb matrix.

For intransitive constructions with no dative, auxiliary verbs consist of the appropriate absolutive agreement marker (also encoding person and number) followed by the tense marker and the root. Note that past tense is double marked:

(8) a. *etorri* *n-a-iz*
come 1SG.ABS-PRES-AUX
'I come'

b. *etorri* *n-in-tz-en*
come 1SG.ABS-PAST-AUX-PAST
'I came'

Intransitive constructions with a dative element are composed in much the same way, with some necessary additions for the inclusion of a dative agreement affix. In addition to the expected dative agreement marker, constructions involving datives have an additional affix that marks agreement with a plural absolutive argument (glossed as APL). As per the previous discussion, though agreement with the dative argument is marked on the auxiliary in this construction, it is still traditionally considered intransitive in linguistic analyses of Basque:

(9) a. *joan* *g-a-tza-izk-izue*
go 1PL.ABS-PRES-AUX-APL-2PL.DAT
'we go to you(pl)'

b. *joan* z-in-tza-izk-ida-n
go 2PL.ABS-PAST-AUX-APL-1SG.DAT.PAST
'you(pl) went to me'

The transitive auxiliaries present interesting modifications to the typical structure of affix order, especially in the past tense. The presence of a 3rd person absolutive element in the past tense transitive construction (9b.) causes a complete restructuring of the affixes, such that the ergative agreement marker is situated in word-initial position, while the absolutive agreement marker is absent. It should be noted that a non-3rd person absolutive argument does not trigger the same affix reordering phenomenon:

(10) a. *ikusi h-ind-u-da-n*
see 2SG.ABS-PAST-AUX-1SG.ERG-PAST
'I saw you'

b. *ikusi z-en-u-en*
see 2PL.ERG-PAST-AUX-PAST
'you(pl) saw it'

Present tense transitive constructions with datives only show agreement with 3rd person absolutive elements. If the absolutive element is 1st or 2nd person, it is not possible for the auxiliary to agree with it. As detailed in Laka's (1996) grammar, "[a]lthough it is possible to combine the different morphemes that would yield the desired output, the combination is nevertheless ungrammatical." He offers the following examples to illustrate this restriction:

(11) a. *Zuk niri liburua saldu d-Ø-ida-zu*
you-ERG I-DAT book-ABS sell 3SG.ABS-AUX-1SG.DAT-2SG.ERG
'You sell the book to me'

b.**Zuk harakinari ni saldu n-Ø-io-zu*
you-ERG butcher-DAT I-ABS sell 1SG.ABS-AUX-3SG.DAT-2SG.ERG
'You sell me to the butcher'

Laka (1996) notes that this restriction is limited to finite verb matrices; infinitival constructions in embedded clauses allow for the type of sentence in (11b.), by virtue of there being no auxiliary or agreement marking for infinitives. This is demonstrated in (12), where the embedded clause provides a grammatically more acceptable version of the illicit sentence in (11b.):

(12) *Gaizki iruitzen za-i-t zu-k ni-Ø harakinar-i saltzea*
wrong seem 3SG.ABS-AUX-1SG.DAT you-ERG I-ABS butcher-DAT sell
'It seems wrong to me for you to sell me to the butcher'

In (12), the embedded clause requires the use of the infinitive form of the verb 'sell', which does not take an auxiliary or any agreement morphology. The auxiliary verb in the matrix clause allows the matrix verb 'seem' to agree with the absolutive subject (expletive 'it' in English) and the first singular dative 'to me'.

The present tense marker is not featured in transitive constructions with datives. Furthermore, the concatenation of affixes occurs in a predictable way, but the root is always null (Ø) when absolutive, ergative, and dative arguments are present. Like their intransitive counterparts, transitive auxiliaries with datives make use of the plural absolutive marker. In the past tense, the affixes are ordered in a way which reflects the trend shown in the class 3 past tense with 3rd person absolutive agreement. As with class 3, past tense forms do not feature an absolutive agreement marker other than the presence of the plural absolutive marker if necessary:

(13) a. *eman d-Ø-izk-ida-zue*
give 3PL.ABS-AUX-APL-1SG.DAT-2PL.ERG
'you(pl) give them to me'
b. *eman g-en-Ø-izk-izue-n*
give 1PL.ERG-PAST-AUX-APL-2PL.DAT-PAST
'we gave them to you(pl)'

Of particular note in the preceding discussion of auxiliary class membership is the affix reordering phenomenon apparent in the past tense of classes 3 and 4, specifically when the main verb's absolutive argument is 3rd person.

5 MODELING BASQUE AUXILIARIES The aim of the current study, then, is to determine whether or not an inferential-realizational account of these auxiliaries can be formulated that is sufficiently robust to account for this affix ordering phenomenon in a clear and succinct fashion. As previously noted, Paradigm Function Morphology (Stump 2001) provides a regimented method for devising a formal account of a language's inflectional morphology. The integral feature of a PFM analysis is the Paradigm Function itself, the algebraic representation of the template of concatenation of morphemes. Ignoring (for the moment) the variable affix ordering found in certain constructions, the simplest forms of Basque auxiliary verbs seem to take on the following structure:

(14) Absolutive agreement - Tense marker - Stem - Dative agreement- Ergative agreement - Tense marker

Note that the template in (14) contains the maximal set of affix possibilities, though it is not necessary that each of these affix positions be filled by an exponent. The typical PFM analysis would then take each of these affix positions and assign them to a series of blocks of rules that govern the phonological form of each affix based on the morphosyntactic properties associated with each specific cell in the paradigm of each affix. Specifically, one block would license absolutive agreement affixes, another ergative agreement affixes, and so on:

(15) Block I:
  i. Rules realizing absolutive agreement prefixes
Block II:
  ii. Rules realizing past and present tense agreement prefixes
Block III:
  iii. Rules realizing the plural absolutive marker
Block IV:
  iv. Rules realizing dative agreement suffixes
Block V:
  v. Rules realizing ergative agreement suffixes
Block VI:
  vi. Rules realizing past tense suffixes

The rule blocks work in conjunction with rules selecting the appropriate stem to realize a given cell in the paradigm. In the event that no rule from a certain block is applicable, the form resulting from the application of that block is the same form that would result without the application of the same block, a process Stump (2001) terms the Identity Function Default.

Using the template in (14) and the rule blocks in (15), a Paradigm Function could then be articulated that stipulates in what order the affixes are attached to the root:

(16) Where L is the auxiliary and σ is a morphosyntactic property set in L's paradigm:

PF(⟨L, σ⟩) = [VI : [V : [IV : [III : [II : [I : ***Stem***(⟨L, σ⟩)]]]]]]

After the appropriate stem is selected, each rule block applies based on the features specified by σ. Block I selects the absolutive agreement prefix, Block II the present or past tense prefix, and so on. While this structure does account for every cell in the present and past tense paradigms of the intransitive auxiliaries, as well as the present tense paradigms of transitive auxiliaries, it clearly fails to result in the forms necessary to complete the transitive past tense paradigms. Specifically, the deviation from the expected affix order illustrated in (10b.) and (13b.) cannot readily be explained given the analysis in (16). Affix order variability is not unique to Basque, so it is important to note that solutions to this type of problem to exist within the Paradigm Function Morphology framework.

One approach to solving this problem would be to propose that the Paradigm Function for Basque auxiliaries is composed of multiple clauses, an analysis which proves useful in accounting for strong and weak declension classes, among other phenomena. The first clause of the Paradigm Function would act as a default and account for the intransitive and present tense transitive auxiliaries, while the second clause accounts for the reordering of affixes when a past tense transitive auxiliary agrees with a third person absolutive argument:

(17) Where L is the auxiliary and σ is a morphosyntactic property set in L's paradigm, then by default, PF(⟨L, σ⟩) = [V : [IV : [III : [II : [I : ***Stem***(⟨L, σ⟩)]]]]] ;
But if σ licenses agreement with a 3rd person absolutive argument in L's past tense transitive paradigm, PF(⟨L, σ⟩) = [II : [IV : [III : [V : [I : ***Stem***(⟨L, σ⟩)]]]]]

While this analysis provides the satisfactory result of capturing the order of affixes, it seems to gloss over some of the intricacies of this rich inflectional system. Specifically, the lack of an absolutive agreement marker in certain past tense transitive forms is an interesting phenomenon that is only demonstrable in this analysis either by positing a null exponent (Ø) for each instance of absolutive agreement in these cells, or making the claim that the absolutive agreement exponent is simply never realized in these cells. Furthermore, this proposal leaves an unanswerable question as to where the absolutive agreement affix rule block should be situated within the second clause paradigm function. In either explanation, since the absolutive agreement affix is never pronounced, it could feasibly be placed in any position. Ultimately, this is an analysis which may be motivated more by engineering the solution rather than accounting for the data.

5.1 CASE MARKING AND AFFIX ORDER An alternative, perhaps more desirable account for the affix ordering variation found in Basque auxiliaries comes from a closer examination of the realizations of ergative and absolutive agreement prefixes in past tense constructions. The following table shows the relevant ergative and absolutive agreement prefixes for each person and number combination; note that the ergative prefixes cumulatively express past tense by default, as ergative agreement is only marked as a prefix in the past tense when the absolutive argument is 3rd person (cf. §4.8).

Figure 1: Basque auxiliary case agreement prefixes

	Absolutive		Ergative
	Present	Past	Past
1sg	*n-*	*n-*	*n-*
2sg	*h-*	*h-*	*h-*
3sg	*d-*	*z-*	*z-*
1pl	*g-*	*g-*	*g-*
2formal	*z-*	*z-*	*z-*
2pl	*z-*	*z-*	*z-*
3pl	*d-*	*z-*	*z-*

Interestingly, in addition to the large amount of syncretism between the present and past tense absolutive agreement prefixes, the ergative agreement cells are identical to their past tense absolutive counterparts. In essence, these fully syncretic paradigms lead to the conclusion that the case agreement prefixes shown in Figure 1 are sensitive only to person and number, but not case. In other words, the morphology selects the appropriate prefix in agreement with the person and number features of the absolutive argument by default, but selects for agreement with the person and number features of the ergative argument in the past tense when the absolutive argument is 3rd person.

This analysis relies on a new formulation of the realization rule blocks accessed by the morphology of Basque when spelling out inflected forms:

(18) Where *x, y,* and *z* are variables over various affixes' phonological realizations:

Block AGR
i. Case agreement (absolutive or ergative) realized by x-prefixation
Block T
ii. Past tense realized by y-prefixation
iii. Present tense realized by z-prefixation
Block APL
iv. Rules realizing the plural absolutive marker
Block DAT
v. Rules realizing dative agreement suffixation
Block ERG
vi. Rules realizing ergative agreement suffixation
Block $SUFF_T$
vii. Rules realizing past tense marker suffixation

It should be noted that the rule blocks in (15) and (18) are abstractions over a much larger set of rules, as each exponent encodes person, number, case, and/or some combination of these morphosyntactic properties.

It is also relevant to discuss the extensive amount of cumulative exponence encoded by many of the affixes and stems. Specifically, while it seems reasonable to propose that each affix has a feature that it primarily encodes, many are sensitive to several different features, including tense, person, number, case, and/or transitivity. A case in point is the previous discussion of how stem selection is sensitive to the main verb's argument structure (cf. §4). In addition to transitivity, auxiliary stems encode agreement in person and number with the absolutive argument of the main verb, and tense.

The case agreement prefixes in Figure 1 provide another interesting example of this cumulative exponence. While the present tense forms always encode agreement with the person and number of the main verb's absolutive argument, past tense forms are realized based on a set of conditions related to transitivity, tense, and the person feature of the absolutive argument. If specific conditions are met, i.e. a transitive, past tense sentence with a 3rd person absolutive argument, then the case agreement prefix in Block AGR selects the appropriate rule based on agreement in person and number with the ergative argument. If this specific set of conditions is not met, then the appropriate rule from the same block applies based on the person and number features of the absolutive argument.

In contrast to the Paradigm Function analysis presented in (17), this analysis affords the benefit of being able to account for the variable affix ordering data without the need for a complex function with multiple clauses or ambiguity:

(19) Where L is the auxiliary and σ is a morphosyntactic property set in L's paradigm:

$$PF(\langle L, \sigma\rangle) = [\ \text{SUFF}_T : [\ \text{ERG} : [\ \text{DAT} : [\ \text{APL} : [\ \text{T} : [\ \text{AGR} : \boldsymbol{Stem}(\langle L,\sigma\rangle)\ ]]]]]]$$

This Paradigm Function licenses the realization of the full set of cells in the indicative paradigms of Basque auxiliaries. Finally, it is important to capture the generalization that in the specific cases where the case prefix marks agreement with the ergative argument, successive application of Block ERG does not occur, as illustrated in the examples in (10) and (13).

5.2 THE PFM FORMALISM This section provides a more complete Paradigm Function Morphology analysis of Basque auxiliaries, detailing the realization rules governing stem and affix selection, rule block conflation, and application of the Paradigm Function as introduced in (17) - (19) of the preceding section.

The following table outlines the feature sets associated with the Basque auxiliary verb system. These are the categories, values, and abbreviations that will be used throughout the Paradigm Function rule schema:

Figure 2. Table of inflectional property Sets for Basque auxiliary verbs

Inflectional category	Permissible values	(Abbreviations)
CLASS	1,2,3,4	(CLASS)
TENSE	past, present	(TNS, pres, past)
ERGATIVE AGREEMENT	1SG, 2SG, 3SG, 1PL, 2FORMAL, 2PL, 3PL, -	(ERG)
ABSOLUTIVE AGREEMENT	1SG, 2SG, 3SG, 1PL, 2FORMAL, 2PL, 3PL,	(ABS)
DATIVE AGREEMENT	1SG, 2SG, 3SG, 1PL, 2FORMAL, 2PL, 3PL, -	(DAT)

The property sets ERG, DAT, and ABS, which encode agreement with the various arguments in the sentence, consist of a combination of person and number. For example, ERG: {PERS:α, NUM:β}. As a logical extension, this representation can then be shortened, ERG: {PERS:1, NUM:sg} = ERG:{1sg}. This type of abbreviation is somewhat conventional, but becomes useful as an intermediate step in a series of abbreviations. Due to the fact that many properties of the Basque auxiliary inflectional system tend to rely on person but not number, or vice versa, it is useful to further simplify the representation in order to maintain clarity. For example, if PERS is specified but NUM isn't, then ABS: {3} is a generalization over 3rd persons singular and plural. Note that the 2nd person singular formal behaves as a plural morphologically (cf. §4.8). In many cases, the exponents realizing 2nd person plural and 2nd person formal are identical. Unless specified, 2PL refers to both 2nd person plural and 2nd singular formal.

In most analyses of Basque morphosyntax, the auxiliary verbs are separated into four classes (cf. §4.8) based on which arguments are required by the main verb's argument structure; 1) absolutive only, 2) absolutive and dative, 3) absolutive and ergative, 4) absolutive, dative, and ergative. These classes are not separate declensions, but rather an attempt to characterize the interaction of exponents required by the Basque morphosyntax in an organized way. This separation into classes is especially helpful when analyzing the affix order variability in certain auxiliaries, as it seems to hinge on the specific argument structure of the main verb and morphotactics involving the interaction between absolutive, ergative, and tense agreement markers. In order to achieve an economy of space and complexity in the realization rules governing stem and affix selection, it is desirable to propose a formal way of accounting for these classes:

(20) Where *m* and *n* are values other than '-' :
ERG: - & DAT: - implies CLASS: 1 (absolutive arguments only)
ERG: - & DAT: *n* implies CLASS: 2 (absolutive and dative arguments)
ERG: *m* & DAT: - implies CLASS: 3 (absolutive and ergative arguments)
ERG: *m* & DAT: *n* implies CLASS: 4 (absolutive, dative, and ergative arguments)

5.2.1 REALIZATION RULES Having outlined the inflectional categories expressed through the auxiliary system, the next step is to create a series of realization rule blocks that the paradigm function will access in generating the paradigms of the auxiliaries. Working from the inside of the Paradigm Function outwards, it is first useful to define the rules governing selection of the appropriate stem based on the morphosyntactic properties associated with specific cells in the paradigm. Note that the general principle underlying stem selection and each successive realization rule block is that the most narrow applicable rule is targeted by the morphology based on the pairing of an auxiliary L and a specific morphosyntactic property set σ:

(21) Basque auxiliary stem selection rules and PFM realization rule blocks

Where L is the auxiliary and σ is a morphosyntactic property set in L's paradigm:

a. ***Stem***(⟨L, σ⟩) = ⟨iz, σ⟩ if {CLASS:1, TNS:pres, ABS:{sg}} ⊆ σ.
b. ***Stem***(⟨L, σ⟩) = ⟨Ø, σ⟩ if {CLASS:1, ABS:3sg} ⊆ σ.
c. ***Stem***(⟨L, σ⟩) = ⟨ra, σ⟩ if {CLASS:1, TNS:pres, ABS:{pl}} ⊆ σ.
d. ***Stem***(⟨L, σ⟩) = ⟨rete, σ⟩ if {CLASS:1, TNS:pres, ABS:2pl} ⊆ σ.
e. ***Stem***(⟨L, σ⟩) = ⟨tz, σ⟩ if {CLASS:1, TNS:past, ABS:{sg}} ⊆ σ.

f. ***Stem***(⟨L, σ⟩) = ⟨Ø, σ⟩ if {CLASS:1, TNS:past, ABS:3sg} ⊆ σ.

g. ***Stem***(⟨L, σ⟩) = ⟨Ø, σ⟩ if {CLASS:1, TNS:past, ABS:{pl}} ⊆ σ.

h. ***Stem***(⟨L, σ⟩) = ⟨r, σ⟩ if {CLASS:1, TNS:past, ABS:3pl} ⊆ σ.

i. ***Stem***(⟨L, σ⟩) = ⟨tza, σ⟩ if {CLASS:2} ⊆ σ.

j. ***Stem***(⟨L, σ⟩) = ⟨za, σ⟩ if {CLASS:2, TNS:pres, ABS:3sg} ⊆ σ.

k. ***Stem***(⟨L, σ⟩) = ⟨u, σ⟩ if {CLASS:3} ⊆ σ.

l. ***Stem***(⟨L, σ⟩) = ⟨itu, σ⟩ if {CLASS:3, ABS:{pl}} ⊆ σ.

m. ***Stem***(⟨L, σ⟩) = ⟨ituzte, σ⟩ if {CLASS:3, ABS:2pl} ⊆ σ.

n. ***Stem***(⟨L, σ⟩) = ⟨uzte, σ⟩ if {CLASS:3, TNS:past, ABS:3 pl} ⊆ σ.

o. ***Stem***(⟨L, σ⟩) = ⟨Ø , σ⟩ if {CLASS:4 } ⊆ σ

Block AGR. [case agreement prefixation]

Rule i.a. X, V, {abs:1sg} → *n*X.

Rule i.b. X, V, {abs:2sg → *h*X.

Rule i.c. X, V, {abs:{3}} → *d*X.

Rule i.d. X, V, {abs:1pl} → *g*X.

Rule i.e. X, V, {abs:2pl} → *z*X.

Rule i.f. X, V, {tns:past ,abs:{3}} → *z*X.

Rule i.g. X, V, {class:2, tns:pres, abs:{3}} → *Ø*X.

Rule i.h. X, V, {erg:τ, tns:past, abs:{3}} → Y

where [AGR : <X,σ:{tns:past, abs:τ}>] = <Y,σ>.

Block T. [tense agreement prefixation]

Rule ii.a. X, V, {tns:pres} → *a*X

Rule ii.b. X, V, {class:1, tns:pres, abs:3pl} → *i*X

Rule ii.c. X, V, {tns:past} → *in*X

Rule ii.d. X, V, {tns:past, abs:{3}} → *i*X

Rule ii.e. X, V, {class:3, tns:past, abs:{1/2sg}} → *ind*X

Rule ii.f. X, V, {class:3, tns:past, abs:{1/2pl}} → *int*X

Rule ii.g. X, V, {class:{3/4}, tns:past, abs:{3}} → *en*X

Block APL. [absolutive plural marker]

Rule iii.a. X, V, {class:{2/4}, abs:{pl}} → X*izk*

Block DAT. [dative agreement suffixation]

Rule iv.a. X, V, {dat:1sg} → X*it*

Rule iv.b. X, V, {dat:2sg} → X*ik*

Rule iv.c. X, V, {dat:3sg} → X*io*

Rule iv.d. X, V, {dat:1pl} → X*igu*

Rule iv.e. X, V, {dat:2formal} → X*izu*

Rule iv.f. X, V, {dat:2pl} → X*izue*

Rule iv.g. X, V, {dat:3pl} → X*ie*

Block ERG. [ergative agreement suffixation]

Rule v.a. X, V, {erg:1sg} → X*t*

Rule v.b. X, V, {erg:2sg} → X*k*

Rule v.c. X, V, {erg:3sg} → X*Ø*

Rule v.d. X, V, {erg:1pl} → X*gu*

Rule v.e. X, V, {erg:2formal} → X*zu*

Rule v.f. X, V, {erg:2pl} → X*zue*

Rule v.g. X, V, {erg:3pl} → X*te*

Block SUFF$_{T}$. [past tense agreement suffixation]

Rule vi.a. X, V, {tns:past} → X*n*

Rule vi.b. X, V, {tns:past, class:1} → X*en*

Rule vi.c. X, V, {tns:past, class:3, abs{3}} → X*en*

In order to formally represent the claim that the case agreement prefixes in Block AGR have the same phonological forms in the past tense, regardless of which type of argument (absolutive or ergative) they are agreeing with, this analysis makes use of a special rule of referral:

(22) Rule i.h. X, V, {erg:τ, tns:past, abs:{3}} → Y

where [AGR : <X,σ:{tns:past, abs:τ}>] = <Y,σ>.

Rules of referral (Zwicky 1986) formally capture the idea that a set of realizations may be inherently based on or tied to other realizations in the schema. These linked realizations may occur between rule blocks or within the same rule block. Rule i.h. of Block AGR shown in (22) above links the realizations of ergative agreement prefixes with their absolutive agreement counterparts. This rule can be read as the pairing of the auxiliary with a property set σ that contains the properties 3rd person absolutive agreement, past tense, and ergative agreement τ, where τ is a variable over the set of permissible person and number combinations for ergative arguments in Basque (cf. Figure 2), being realized as Y. The variable Y can be interpreted in the second clause of this rule as the resulting realization from the same block where the auxiliary is paired with a property set σ that contains the properties past tense and absolutive agreement τ. It is important to note that the consistency of the variable τ in both clauses of the rule is necessary to capture the generalization that past tense absolutive and ergative agreement prefixes with the same person and number features share identical phonological realizations.

6. COMPUTATIONAL MODELING OF BASQUE AUXILIARIES An added benefit of the inferential-realization approach to inflectional morphology is the ability to model the proposed analysis computationally, thus enhancing the accuracy of the formalism by demonstrating its robustness. Though a PFM-specific implementation exists, the current study uses the DATR (Evans & Gazdar 1996) framework to model the preceding analysis of Basque auxiliary verbs. Modeling PFM analyses in DATR is by not without precedent; Gazdar (1992) argues for the preference of using DATR to implement PFM analyses, citing the utility of DATR as a general purpose language for modeling various aspects of lexical description (i.e. phonology, morphology, syntax, etc.) as a principal motivation. Stump (2001) also provides his own method of implementing a PFM analysis of Bulgarian verb inflection in DATR. The present analysis of Basque auxiliaries draws on the insights provided by these two works, with some necessary innovations to more fully account for the extremely complex nature of agreement expressed through stem selection and affixation in the auxiliaries. What follows is a general overview of the DATR model of Basque auxiliary verbs (see Appendix I for the full DATR theory).

6.1 VARIABLES IN DATR The DATR syntax allows for variables to be defined for later use in the program. These variables are often employed in two specific ways. First, variables can be used to create a Finite State Transducer for the purpose of handling morphophonological processes, spelling rules, etc. Second, variables can represent generalizations over the permissible values of inflectional categories (see Figure 1, §5.1). The current model makes use of several such variables in order to many properties of the Basque auxiliary inflectional system rely on tense, case, person, number, or some combination of these features.

(23) Morphosyntactic feature variables for Basque auxiliaries

```
#vars $num: sg pl.          #vars $pers: 1 2 3.
#vars $enum: sg pl.         #vars $epers: 1 2 3.
#vars $dnum: sg pl.         #vars $dpers: 1 2 3.

#vars $tense: past pres.    #vars $case: abs erg dat.
```

The variables $tense and $case are straightforward, so they will not be discussed further than to say they allow for generalization over tense and case, respectively. Note that for the variables abstracting over number and person, there are three (3) iterations of each variable, though with different names. One minor limitation of the DATR syntax is the inability to allow the same variable to represent different members of the set in the same path. This necessitates different variables for the person and number features of absolutive ($num/$pers), ergative ($enum/$epers). and dative ($dnum/$dpers) arguments.

6.2 THE PARADIGM FUNCTION IN DATR The DATR hierarchy is composed of various nodes that inherit from and/or provide information and structure to other nodes. The top node is a simple Finite State Transducer that characterizes some morphophonological processes/orthographic rules. The AUX node provides the backbone of the analysis; the <form> path, following Gazdar (1992), acts as a formulation of the Paradigm Function.

(24) The Paradigm Function represented as <form>

```
<form> == FST:<"<<slot1> "<case_agr>" <slot2> "<tense_agr>"
                 <slot3> "<root>"      <slot4> "<apl>"
                 <slot5> "<dat>"       <slot6> "<erg_agree>"
                 <slot7> "<past>" pf>">
```

The function <form> can be read as the application of the phonological rules stipulated in the FST node applied to the result of the slotting of selected affixes into slots defined within the function itself. In order to model agreement, these slots are represented in the <form> function as the pairing of a numbered slot with the morphosyntactic properties of the affix that will occupy it. The path <pf> is realized as σ, which is in turn realized as the morphosyntactic property set associated with the cell of the paradigm being queried:

(25) pf> == , σ
<σ> == "<tense>" abs "<abs>" erg "<erg>" dat "<dat>"

This allows for the output of a query for a set of morphosyntactic properties to resemble Stump's PFM formalism; cells in a paradigm are represented as the concatenation of the appropriate affixes paired with the set of morphosyntactic properties that license them. As in the PFM formalism, these morphosyntactic properties are represented as σ.

In order to model the agreement patterns of the various affixes, the top node also contains pairings of the Paradigm Function slots with the nodes where agreement takes place. An example of this is provided in (26):

(26) <slot1> == agr1 <agr1> == CASE_AGREE:<>
<slot2> == agr2 <agr2> == TAGR:<>

Each slot is tied to the corresponding agreement path that points to the specific node in the hierarchy that deals with agreement of the appropriate affix. Slot 1 is linked to the node realizing case agreement prefixes, slot 2 with the node realizing tense prefixes, and so on.

6.3 CUMULATIVE EXPONENCE As per the previous discussion, though each affix primarily encodes a specific morphosyntactic property (i.e. case agreement, tense agreement, etc.), the Basque inflectional system has a great deal of cumulative exponence. In the DATR model, this is captured by the AuxDefinitions node, which breaks down the affix slots from the <form> function into the morphosyntactic properties needed to fully evaluate agreement for each affix. An example definitions is provided in (27):

(27) <tense_agr> == "<tense>" abs "<abs>" erg "<erg>" dat "<dat>"

Tense agreement prefixes vary based on the argument structure of the main verb, which is demonstrated in the AuxDefinitions node as the path <tense_agr> being defined as the concatenation of the tense, absolutive, ergative, and dative features specified at the query level. This string is then evaluated at the TAGR node:

(28) a. <$tense abs $pers $num erg $epers $enum dat $dpers $dnum> == <>
b. <past abs $pers $num erg $epers pl dat $dpers $dnum> == e n <>

The path in (28a.), taken from the TAGR node shows that the result of evaluating the tense agreement definition in (27) when the main verb requires all three absolutive, ergative, and dative arguments is null (Ø). In other words, by default, tense is not marked as a prefix in this construction. This default is then overridden in (28b.), which demonstrates the fact that past tense forms in this construction do encode past tense with the prefix *en*- when the ergative argument is plural.

6.4 CASE AGREEMENT Prefixes realizing case agreement are sensitive to tense and the argument structure of the main verb. The current analysis models this in much the same way as tense agreement prefixes, with paths involving strings of morphosyntactic properties being evaluated at the CASE_AGREE node:

(29) a. <pres abs 3 $num erg $epers $enum> == CASE_AGREE:<"<tense>" "<abs>">
b. <past abs 3 $num erg $epers $enum> == CASE_AGREE:<"<tense>" "<erg>">

The paths in (29) demonstrate the case prefix phenomenon relevant to the analysis presented. Taken from the CASE_AGREE node, these paths are critical for the case agreement prefix to agree with the ergative argument specifically in past tense forms with a 3rd person absolutive argument. These paths result in the evaluation of the specified tense with the person and number features of the appropriate affix at subsequent paths within the same node:

(30)

```
<$tense 1 sg> == n <>
<$tense 1 pl> == g <>
<$tense 2 sg> == h <>
<$tense 2 formal> == z <>
<$tense 2 pl> == <$tense 2 formal>
<pres 3 $num> == d <>
<past 3 $num> == z <>
```

These paths represent the realizations of the case agreement prefixes, while paths like the ones in (30) allow the agreement of these realizations with the appropriate argument (absolutive or ergative). This allows the model to represent both the realization and conflation rules from the PFM analysis above (cf. §5).

6.5 STEM SELECTION Stem selection is logically correlated to the argument structure of the main verb. This is represented in the model as sensitivity to whether or not ergative and dative arguments are required by the main verb (absolutive arguments are obligatorily required). This definition is evaluated at the ROOT node, which then sorts the queried strings to be evaluated at one of four lexical entry nodes:

(31)

```
<erg 0 dat 0> == Izan_1:<"<tense>" "<abs>">
<erg 0 dat $dpers $dnum> == Izan_2:<"<tense>" "<abs>">
<erg $epers $enum dat 0> == Edun_1:<"<tense>" "<abs>">
<erg $epers $enum dat $dpers $dnum> == Edun_2:<"<tense>" "<abs>">
```

The ROOT node very much resembles the class distinctions elaborated in (20), and similarly allows for an economy of rule complexity within the lexical entries they point to. These lexical entries are the verbs that the auxiliary stems derive from. Both '*izan*' and '*edun*' have two separate entries; Izan_1 has absolutive agreement only, Izan_2 has absolutive and dative agreement, Edun_1 has absolutive and ergative agreement, Edun_2 has absolutive, ergative, and dative agreement. The lexical entries themselves contain rules for realizing the appropriate stem, some examples of which are provided (see Appendix I for the full hierarchy including the full set of lexical entry nodes):

```
(32)   Izan_2:
           <> == ROOT
           <$tense $pers $num> == tz a <>
           <pres 3 $num> == z a <>.
       Edun_2:
           <> == ROOT
           <$tense $pers $num> == <>.
```

6.6 EVALUATING THE MODEL Following the ideas present in Gazdar (1992), sample queries are used to demonstrate the functionality of the theory. Each sample query has specific person and number features associated with the main verb's arguments. Each entry also has a tense feature for agreement purposes. The <form> function and definition nodes apply these features to the necessary rule blocks in order to select the appropriate affixes and build the auxiliaries based on the specified features. Additional queries can be formed either by changing the values of one of more of the properties of an existing sample query or creating additional entries that specify the same basic features as the ones given. A value of zero (0) for the ergative and/or dative paths indicates that the main verb does not have these arguments as part of their argument structure; absolutive arguments are obligatorily used in any construction:

```
(33)    W4a:
            <> == Edun_2
            <abs> == 3 pl
            <erg> == 1 sg
            <dat> == 1 sg
            <tense> == pres.
        W4b:
            <> == W4a
            <tense> == past.
```

The sample query W4a contains the morphosyntactic features necessary to evaluate the auxiliary form that agrees with a 3rd person plural absolutive argument, 1st person singular ergative argument, and 1st person singular dative argument in the present tense construction. As all three types of arguments are required for agreement, the sample query inherits from the appropriate lexical entry, Edun_2, for stem realization purposes. W4b realizes the past tense corollary of W4a by inheriting its features and overriding the value of the path <tense>.

Gazdar (1992) comments that the #show path for PFM analyses in DATR should contain the path <form>, as this allows the Paradigm Function defined as <form> to be evaluated at the level of the sample queries. This theory does the same, with the addition of the path <σ> which is defined as the morphosyntactic property set that is associated with a particular sample query. The resulting output theorems can be seen as the pairing of an auxiliary as the evaluation of <form> based on a specific morphosyntactic property set with that same property set. In this way, the output theorem pairs are closely aligned with the outputs of a traditional PFM analysis. The theorems resulting from the evaluation of the sample queries in (33) are provided to demonstrate the form of the model's output:

(34) W4a:<form> = d i z k i d a t , σ.
W4a:<σ> = pres abs 3 pl erg 1 sg dat 1 sg.

W4b:<form> = n i z k i d a n , σ.
W4b:<σ> = past abs 3 pl erg 1 sg dat 1 sg.

7 DISCUSSION The Basque data offer an interesting opportunity to demonstrate the resilience of inferential-realizational theory in accounting for typologically complex patterns of inflection in a robust manner. Perhaps the most desirable facet of the Paradigm Function Morphology analysis presented in §5 and the DATR model in §6 is the ability of these theories to exhaustively capture the exceedingly large amount of cumulative exponence found in the Basque auxiliary affixes in a formally testable way. A potential area of discussion related the current analysis can be linked to the specific choice of formalism used to model it. One the one hand, The decision to implement the PFM analysis of Basque auxiliaries in DATR is motivated by the same principles that prompted Gazdar (1992) to 'translate' PFM analyses of Swahili inflection into DATR, especially in light of the widespread usage of DATR to model lexical representation across several subfields of linguistics, including morphology and syntax, among others. On the other hand, one potential shortcoming of DATR implementations of PFM analyses can be seen in the complexity of some of the DATR pathways. While both implementations make use of defaults that are inherited throughout the model, one key difference can be seen in how they represent the ordering of attributes in a rule's left-hand side. DATR requires these attributes to be ordered, while on the other hand PFM encodes them as an unordered set. For example, the 3rd person plural absolutive marker *d-* is specified in DATR as the inherently ordered path <3rd plural absolutive>, while the same attributes are represented in PFM as the unordered set {3rd, plural, absolutive}. While in many regards this difference may seem trivial, it does start to show a noticeable effect when dealing with the large amount of cumulative exponence in a language like Basque. In short, the PFM analysis can achieve a much greater economy of simplicity within the realization rules, as the unordered feature set can be shortened to abstract over a large amount of feature sets if certain features aren't distinguished within a particular affix. By contrast, the ordered path in DATR must necessarily include all of the features it is defined to encode, which results in more complex realization rules in certain nodes (see Appendix I). While this distinction could be seen as partially cosmetic, it should be noted that the PFM feature sets can also generate the same paradigms with fewer rules than DATR as a result. This and other theoretical concerns have led to the development of KATR (Finkel et al. 2002), an extension of DATR that incorporates the use of feature sets rather than paths. It is reasonable to posit that it would be useful to represent the highly complex, interconnected nature of the Basque auxiliary system within the KATR framework if a more economical set of realization rules is desirable. Ultimately, regardless of the specific implementation chosen, the resulting analysis would provide a comprehensive and robust account of Basque auxiliary agreement and affixation, covering various phenomena that have been described and theorized about for over a century.

Appendix I: DATR Theory - PFM-style Analysis of Basque Auxiliaries

```
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                           %
% File:             basqueaux.dtr                                           %
% Purpose:          PFM-style analysis of Basque auxiliary verbs in DATR    %
% Author:           Parker Brody 22 March, 2014                             %
% Email:            parkerlbrody@uky.edu                                    %
%                                                                           %
%                                                                           %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                           %
%    0 The model: the theory presented here represents a DATR               %
%    implementation of the PFM-style (Stump 2001) analysis of Basque        %
%    auxiliary verbs. Modeling PFM analyses in DATR is by not without       %
%    precedent; Gazdar (1992) argues for the preference of using DATR to    %
%    implement PFM analyses.                                                %
%    Stump (2001) also provides his own method of implementing a PFM        %
%    analysis of Bulgarian verb inflection in DATR.                         %
%    The present analysis of Basque auxiliaries draws on the insights       %
%    provided by these two works, with some necessary innovations to        %
%    more fully account for the extremely complex nature of agreement       %
%    featured through affixation in the auxiliaries.                        %
%                                                                           %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                           %
%    1 Variables: the #vars command allows variables to be defined          %
%    for later use in the program. This is especially helpful in the        %
%    implementation of an FST in DATR, as the variable $abc can be used     %
%    to represent any letter. This is very useful way to represent the      %
%    necessity of an FST to accept and process the given language data.     %
%    In addition to the variables governing spelling, which allow the FST   %
%    to do some morphophonological processing, this theory makes use of     %
%    several other variables, an explanation of which follows:              %
%                                                                           %
%    The variables $tense and $case are straightforward, so they will not   %
%    be discussed further than to say they allow for generalization over    %
%    tense and case, respectively.                                          %
%    Note that for the variables abstracting over number and person, there  %
%    are three (3) iterations of each variable, though with different names.%
%    One minor limitation of the DATR syntax is the inability to allow the  %
%    same variable to represent different members of the set in the same    %
%    path. This necessitates different variables for the person and number  %
%    features of absolutive ($num/$pers), ergative ($enum/$epers), and      %
%    dative ($dnum/$dpers) arguments.                                       %
%                                                                           %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %

#vars $num: sg pl formal.
#vars $enum: sg pl formal.
#vars $dnum: sg pl formal.

#vars $pers: 1 2 3.
#vars $epers: 1 2 3.
#vars $dpers: 1 2 3.

#vars $tense: past pres.
#vars $case: abs erg dat.
```

```
#vars $abc: a b c d e f g h i j k l m n o p q r s t tz u v w x y z , σ.
#vars $cons: b c d f g h j k l m n p q r s t tz v w x y z.
#vars $vow: a e i o u.

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                         %
%    2 The DATR hierarchy is composed of various nodes that inherit from   %
%    and/or provide information and structure to other nodes. The top node %
%    is a simple finite state transducer that performs some phonological   %
%    processes. The AUX node provides the backbone of the analysis; the    %
%    <form> path, following Gazdar (1992), acts as a formulation of the    %
%    Paradigm Function. This function form can be read as the application %
%    of the phonological rules stipulated in the FST node applied to the   %
%    result of the slotting of selected affixes into slots defined within  %
%    the function itself. In order to model agreement, these slots are     %
%    represented in the form function as the pairing of a numbered slot    %
%    with the morphosyntactic properties of the affix that will occupy it. %
%                                                                         %
%    The paths <pf> and <paradigm> allow for the output of a query for a   %
%    set of morphosyntactic properties to resemble Stump's PFM formalism;  %
%    cells in a paradigm are represented as the concatenation of the       %
%    appropriate affixes paired with the set of morphosyntactic properties %
%    that license them. As in the PFM formalism, these morphosyntactic     %
%    properties are represented as σ.                                      %
%                                                                         %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %

FST:                                          % morphophonological processes
   <> ==
   <$abc> == $abc <>
   <$vow t $cons> == $vow d a $cons <>
   <$cons n> == $cons e n <>
   <u n> == u e n <>
   <t u t e> == t u z t e <>.

AUX:
   <form> == FST:<"<<slot1> "<case_agr>"  <slot2> "<tense_agr>"
                    <slot3> "<root>"      <slot4> "<apl>"
                    <slot5> "<dat>"       <slot6> "<erg_agree>"
                    <slot7> "<past>" pf>">
   <pf> == , σ
   <σ> == "<tense>" abs "<abs>" erg "<erg>" dat "<dat>"


% % %                       2.1 Agreement sites                       % % %
%                                                                         %
%    The AUX node also features paths that define the pattern of affixes   %
%    and the node where each affix is generated. These are crucial for the %
%    DATR theory to select the correct affix based on stipulated           %
%    morphosyntactic properties and then slot the affixes into the correct %
%    order as defined by the form function.                                %
%                                                                         %

   <slot1> == agr1   <agr1> == CASE_AGREE:<>
   <slot2> == agr2   <agr2> == TAGR:<>
   <slot3> == agr3   <agr3> == ROOT:<>
   <slot4> == agr4   <agr4> == APL:<>
   <slot5> == agr5   <agr5> == DAT:<>
   <slot6> == agr6   <agr6> == ERG_AGREE:<>
   <slot7> == agr7   <agr7> == PAST:<>.
```

```
% % %                      2.2 Definitions                          % % %
%                                                                       %
%    The AuxDefinitions node provides definitions of which properties are   %
%    responsible for the agreement features of various affixes. In other    %
%    words, affixes in Basque auxiliaries typically agree with at least     %
%    one (if not several) morphosyntactic properties of the verbs core      %
%    arguments. Auxiliary roots, tense markers, and case agreement markers  %
%    all interact with the morphosyntactic properties of these arguments    %
%    in their selection. These properties are stipulated in the lexical     %
%    entries. For example, the tense prefix <tense_agr> interfaces with     %
%    the tense of the verb, as well as the person and number features of    %
%    any and all core arguments of the verb (absolutive, ergative, and/or   %
%    dative).                                                               %
%                                                                       %

AuxDefinitions:
   <> == AUX
   <tense_agr> == "<tense>" abs "<abs>" erg "<erg>" dat "<dat>"
   <case_agr> == "<tense>" abs "<abs>" erg "<erg>"
   <erg_agree> == <case_agr>
   <past> == "<tense>"
   <root> == erg "<erg>" dat "<dat>"
   <apl> == "<dat>".

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                       %
%    3 Stem selection interfaces with the transitivity of the verb, as well %
%    as the person and number features of the verb's core arguments.        %
%    Though the auxiliary root paradigm is somewhat defective, roots always %
%    agree with the absolutive argument in person and number, regardless of %
%    transitivity. The ROOT node takes transitivity into account, sorting   %
%    stem selection based on what types of arguments are licensed by the   %
%    main verb. The resulting output is evaluated at the level of the       %
%    lexical entries, which contain rules realizing their stem(s).          %
%                                                                       %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %

ROOT:                                          % stem selection based on
   <> == AuxDefinitions                        % argument structure
   <erg 0 dat 0> == Izan_1:<"<tense>" "<abs>">
   <erg 0 dat $dpers $dnum> == Izan_2:<"<tense>" "<abs>">
   <erg $epers $enum dat 0> == Edun_1:<"<tense>" "<abs>">
   <erg $epers $enum dat $dpers $dnum> == Edun_2:<"<tense>" "<abs>">.

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                       %
%    4 Realization rule blocks written as DATR nodes: Each node represents  %
%    a stem selection or realization rule block. Note that rule block       %
%    nodes typically consist of several complex rules that reflect the      %
%    extensive cumulative exponence present in the auxiliary system. For    %
%    example, the tense prefix primarily encodes tense, but is also         %
%    sensitive to the person and number features of the main verb's         %
%    arguments. These nodes evaluate the result of the definitions found    %
%    in the AuxDefinitions node.                                            %
%                                                                       %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %


CASE_AGREE:                                     % Block AGR
   <> == AUX
   <$tense abs $pers $num erg 0> ==
            CASE_AGREE:<"<tense>" abs "<abs>" dat "<dat>">
```

```
   <$tense abs $pers $num erg $epers $enum> ==
            CASE_AGREE:<"<tense>" abs "<abs>" dat "<dat>">

   <pres abs 3 $num erg $epers $enum> == CASE_AGREE:<"<tense>" "<abs>">
   <past abs 3 $num erg $epers $enum> == CASE_AGREE:<"<tense>" "<erg>">

   <$tense abs $pers $num dat 0> == CASE_AGREE:<"<tense>" "<abs>">
   <$tense abs $pers $num dat $dpers $dnum> == CASE_AGREE:<"<tense>" "<abs>">

   <pres abs 3 $num dat $dpers $dnum> == <>

   <$tense 1 sg> == n <>
   <$tense 1 pl> == g <>
   <$tense 2 sg> == h <>
   <$tense 2 formal> == z <>
   <$tense 2 pl> == <$tense 2 formal>
   <pres 3 $num> == d <>
   <past 3 $num> == z <>.

TAGR:                                         % Block T
   <> == AUX
   <$tense abs $pers $num erg $epers $enum dat $dpers $dnum> == <>
   <past abs $pers $num erg $epers pl dat $dpers $dnum> == e n <>

   <$tense abs $pers $num erg 0 dat 0> == TAGR:<"<tense>" "<abs>">
   <$tense abs $pers $num erg 0 dat $dpers $dnum> == TAGR:<"<tense>" "<abs>">
   <pres abs $pers $num erg $epers $enum dat 0> == TAGR:<"<tense>" "<abs>">
   <pres abs 3 $num erg 0 dat $dpers $dnum> == <>
   <pres abs 3 $num erg $epers $enum dat 0> == <>
   <past abs 3 sg erg 0 dat $dpers $dnum> == i <>

   <past abs $pers sg erg $epers $enum dat 0> == i n d <>
   <past abs $pers pl erg $pers $num dat 0> == i n t <>
   <past abs 3 $num erg $epers $enum dat 0> == <>
   <past abs 3 $num erg $epers pl dat 0> == e n <>

   <pres $pers $num> == a <>
   <past $pers $num> == i n <>
   <$tense 3 pl> == i <>
   <past 3 sg> == <>.

APL:                                          % Block APL
   <> == AUX
   <0> == <>
   <$pers $num> == APL:<abs "<abs>">
   <abs $pers sg> == <>
   <abs $pers pl> == i z k <>.

DAT:                                          % Block DAT
   <> == AUX
   <0> == <>
   <1 sg> == i t <>
   <1 pl> == i g u <>
   <2 sg> == i k <>
   <2 formal> == izu
   <2 pl> == i z u e t e <>
   <3 sg> == i o <>
   <3 pl> == i e <>.



ERG_AGREE:                                    % Block ERG
   <> == AUX
```

```
   <$tense abs $pers $num erg $epers $enum> == ERG_AGREE:<"<erg>">
   <$tense abs $pers $num erg 0> == <>
   <past abs 3 $num erg $epers $enum> == <>
   <1 sg> == t <>
   <1 pl> == g u <>
   <2 sg> == k <>
   <2 formal> == z u <>
   <2 pl> == z u e <>
   <3 sg> == <>
   <3 pl> == t e <>.

PAST:                                                  % Block SUFFt
   <> == AUX
   <pres> == <>
   <past> == n <>.

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                           %
%    5 Lexical Entries are the verbs that the auxiliary stems derive from   %
%    Both 'izan' and 'edun' have two separate entries; Izan_1 has           %
%    absolutive agreement only, Izan_2 has absolutive and dative agreement, %
%    Edun_1 has absolutive and ergative agreement, Edun_2 has absolutive,   %
%    ergative, and dative agreement. The ROOT node these lexical entries    %
%    inherit from select the appropriate entry based on which arguments     %
%    they agree with. The lexical entries themselves contain rules for      %
%    realizing the appropriate stem.                                        %
%                                                                           %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %

Izan_1:
   <> == ROOT
   <pres $pers sg> == i z <>
   <pres $pers pl> == r a <>
   <pres 2 formal> == r a <>
   <pres 2 pl> == r e t e <>
   <past $pers sg> == tz <>
   <$tense 3 sg> == <>
   <past 1 pl> == <>
   <past 2 formal> == <past 1 pl>
   <past 2 pl> == e t <>
   <past 3 pl> == r <>.

Izan_2:
   <> == ROOT
   <$tense $pers $num> == tz a <>
   <pres 3 $num> == z a <>.

Edun_1:
   <> == ROOT
   <$tense $pers sg> == u <>
   <$tense $pers pl> == i t u <>
   <$tense 2 pl> == i t u z t e <>
   <past 3 pl> == i t u z t e <>.

Edun_2:
   <> == ROOT
   <$tense $pers $num> == <>.
```

```
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                           %
%    6 Sample queries are used to evaluate the model. Following the ideas   %
%    present in Gazdar (1992), these queries are meant to demonstrate the   %
%    functionality of the theory. Each sample query has specific person     %
%    and number features associated with the main verb's hypothetical       %
%    absolutive, ergative, and dative arguments. Each entry also has a      %
%    tense feature for agreement purposes. The function and definition      %
%    nodes apply these features to the necessary rule blocks in order to    %
%    select the appropriate affixes and build the correct auxiliaries.      %
%                                                                           %
%    The example queries provided do not cover the full set of inflected    %
%    forms, rather they are meant to provide a representative sample.       %
%    W1a-g generate the present tense paradigm of auxiliaries that are      %
%    associated with intransitive constructions with no dative as a         %
%    demonstration of a sample of the overall paradigm. The paradigms of    %
%    auxiliaries that encode agreement with more than one argument are      %
%    exceedingly large by contrast. The remaining sample queries are used   %
%    to demonstrate various interesting phenomena in auxiliary system.      %
%                                                                           %
%    Additional queries can be formed either by changing the values of one  %
%    of more of the properties of an existing sample query or creating      %
%    additional entries that specify the same basic features as the ones    %
%    given. A value of zero (0) for the ergative and/or dative paths        %
%    indicates that the main verb does not have these arguments as part of  %
%    their argument structure; absolutive arguments are obligatorily used   %
%    in any construction.                                                   %
%                                                                           %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %


W1a:                           % present intransitive with no dative
   <> == Izan_1                % W1a-g generate this partial paradigm
   <abs> == 1 sg
   <erg> == 0
   <dat> == 0
   <tense> == pres.            % change to past to generate past paradigm

W1b:                           % W1b-g inherit from W1a and override <abs>
   <> == W1a
   <abs> == 2 sg.

W1c:
   <> == W1a
   <abs> == 3 sg.

W1d:
   <> == W1a
   <abs> == 1 pl.

W1e:
   <> == W1a
   <abs> == 2 formal.

W1f:
   <> == W1a
   <abs> == 2 pl.

W1g:
   <> == W1a
   <abs> == 3 pl.
```

```
W2a:                          % Absolutive and dative agreement
   <> == Izan_2
   <abs> == 3 sg
   <erg> == 0
   <dat> == 1 sg
   <tense> == pres.

W2b:                          % Past tense form of W2a
   <> == W2a
   <tense> == past.

W2c:                          % Includes plural absolutive marker
   <> == W2b
   <abs> == 3 pl.

W3a:                          % Absolutive and ergative agreement
   <> == Edun_1
   <abs> == 1 sg
   <erg> == 2 sg
   <dat> == 0
   <tense> == pres.

W3b:                          % Past tense form of W3a
   <> == W3a                  % Case prefix agrees with absolutive
   <tense> == past.

W3c:                          % Past tense transitive w/3rd person absolutive
   <> == W3b
   <abs> == 3 sg.             % Case prefix agrees with ergative

W3d:                          % Same as W3c but with 3rd pl absolutive
   <> == W3b
   <abs> == 3 pl.

W4a:                          % Absolutive, ergative, and dative agreement
   <> == Edun_2
   <abs> == 3 pl
   <erg> == 1 sg
   <dat> == 1 sg
   <tense> == pres.

W4b:                          % Past tense form of W4a
   <> == W4a                  % case prefix agrees with ergative
   <tense> == past.

W4c:                          % Another past tense form from the same paradigm
   <> == W4b                  % case prefix agrees with ergative
   <erg> == 1 pl.

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                           %
%    7 Gazdar (1992) comments that the #show path for PFM analyses in DATR  %
%    should contain the path <form>, as this allows the Paradigm Function   %
%    defined as <form> to be evaluated at the level of the sample queries.  %
%    This theory does the same, with the addition of the path <σ> which is  %
%    defined as the morphosyntactic property set that is associated with a  %
%    particular sample query. The resulting output theorems can be seen as  %
%    the pairing of an auxiliary as the evaluation of <form> based on a     %
%    specific morphosyntactic property set with that same property set.     %
%    In this way, the output theorem pairs are closely aligned with the     %
%    outputs of a traditional PFM analysis.                                 %
%                                                                           %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
```

```
#show <form> <σ>.
#hide FST AUX AuxDefinitions ROOT CASE_AGREE TAGR APL ERG_AGREE PAST Izan_1
Izan_2 Edun_1 Edun_2.

% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
%                                                                           %
%    SAMPLE THEOREMS are the outputs resulting from evaluating the queries  %
%    provided.                                                              %
%                                                                           %
%           W1a:<form> = n a i z , σ.                                       %
%           W1a:<σ> = pres abs 1 sg erg 0 dat 0.                            %
%                                                                           %
%           W1b:<form> = h a i z , σ.                                       %
%           W1b:<σ> = pres abs 2 sg erg 0 dat 0.                            %
%                                                                           %
%           W1c:<form> = d a , σ.                                           %
%           W1c:<σ> = pres abs 3 sg erg 0 dat 0.                            %
%                                                                           %
%           W1d:<form> = g a r a , σ.                                       %
%           W1d:<σ> = pres abs 1 pl erg 0 dat 0.                            %
%                                                                           %
%           W1e:<form> = z a r a , σ.                                       %
%           W1e:<σ> = pres abs 2 formal erg 0 dat 0.                        %
%                                                                           %
%           W1f:<form> = z a r e t e , σ.                                   %
%           W1f:<σ> = pres abs 2 pl erg 0 dat 0.                            %
%                                                                           %
%           W1g:<form> = d i r a , σ.                                       %
%           W1g:<σ> = pres abs 3 pl erg 0 dat 0.                            %
%                                                                           %
%           W2a:<form> = z a i t , σ.                                       %
%           W2a:<σ> = pres abs 3 sg erg 0 dat 1 sg.                         %
%                                                                           %
%           W2b:<form> = z i tz a i d a n , σ.                              %
%           W2b:<σ> = past abs 3 sg erg 0 dat 1 sg.                         %
%                                                                           %
%           W2c:<form> = z i tz a i z k i d a n , σ.                        %
%           W2c:<σ> = past abs 3 pl erg 0 dat 1 sg.                         %
%                                                                           %
%           W3a:<form> = n a u k , σ.                                       %
%           W3a:<σ> = pres abs 1 sg erg 2 sg dat 0.                         %
%                                                                           %
%           W3b:<form> = n i n d u k e n , σ.                               %
%           W3b:<σ> = past abs 1 sg erg 2 sg dat 0.                         %
%                                                                           %
%           W3c:<form> = h u e n , σ.                                       %
%           W3c:<σ> = past abs 3 sg erg 2 sg dat 0.                         %
%                                                                           %
%           W3d:<form> = h i t u z t e n , σ.                               %
%           W3d:<σ> = past abs 3 pl erg 2 sg dat 0.                         %
%                                                                           %
%           W4a:<form> = d i z k i d a t , σ.                               %
%           W4a:<σ> = pres abs 3 pl erg 1 sg dat 1 sg.                      %
%                                                                           %
%           W4b:<form> = n i z k i d a n , σ.                               %
%           W4b:<σ> = past abs 3 pl erg 1 sg dat 1 sg.                      %
%                                                                           %
%           W4c:<form> = g e n i z k i d a n , σ.                           %
%           W4c:<σ> = past abs 3 pl erg 1 pl dat 1 sg                       %
%                                                                           %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
% % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %
```

Appendix II: Paradigms

The following paradigms are reworked from Saltarelli (1988) and Laka (1996), with attempts made to fill in null exponents for the sake of clarity. Some null exponents are due to the defectiveness of the verbs that the auxiliary roots are formed from, others are null due to phonological processes that always delete their exponents**.** The forms represented in the following paradigms focus on the present and past indicative forms. Blank spaces in the paradigms correspond to plural markers; there are logical gaps among the singular persons.

The overall organization of the paradigm is meant to display the order of the morphemes in spellout. In other words, the first column has person and number combinations, and the subsequent columns are arranged in the order the final inflected form will appear. For the Class 1 paradigms, this leads to a very traditional reading of the paradigm from left to right. The complication arises in the paradigms for Classes 2-4 in which the ergative and or dative agreement markers are not necessarily read linearly as may be expected at first glance. Instead, the chart can be read straight across from the first morpheme until either the dative or ergative column appears. At this point, it becomes necessary to check what combination of person and number is appropriate for the dative/ergative argument in the sentence and judge the correct agreement marker accordingly. This is done to achieve an economy of space, as the full paradigms of Basque auxiliaries are extremely large; in the present tense section of the Class 2 paradigm alone, each of the seven strings resulting from the possible logical person and number combinations related to the absolutive argument can split in seven ways for dative agreement. The past tense paradigm behaves in much the same way. For comparison, the partial paradigm of present tense Class 2 forms is shown in order to give an idea of the large size of the full paradigm. Due to the fact that the cells realizing 2nd person formal and 2nd person plural absolutive agreement are fully syncretic in this partial paradigm, they have been combined into the 2 plural column to save space:

	ABSOLUTIVE AGREEMENT					
DATIVE AGREEMENT	1sg	2sg	3sg	1pl	2pl*	3pl
1sg	*natzait*	*hatzait*	*zait*	*gatzaizkit*	*zatzaizkit*	*zaizkit*
2sg	*natzaik*	*hatzaik*	*zaik*	*gatzaizkik*	*zatzaizkik*	*zaizkik*
3sg	*natzaio*	*hatzaio*	*zaio*	*gatzaizkio*	*zatzaizkio*	*zaizkio*
1pl	*natzaigu*	*hatzaigu*	*zaigu*	*gatzaizkigu*	*zatzaizkigu*	*zaizkigu*
2formal	*natzaizu*	*hatzaizu*	*zaizu*	*gatzaizkizu*	*zatzaizkizu*	*zaizkizu*
2pl	*natzaizuete*	*hatzaizuete*	*zaizuete*	*gatzaizkizuete*	*zatzaizkizuete*	*zaizkizuete*
3pl	*natzaie*	*hatzaie*	*zaie*	*gatzaizkie*	*zatzaizkie*	*zaizkie*

For present tense Class 4 paradigms, inflected forms split seven ways for dative agreement, the results of which then split in seven ways each for ergative agreement. Furthermore, the traditional way of presenting Basque auxiliary paradigms repeated here has the added benefit of demonstrating the breakdown of affixes in an organized and intelligible way. Cells that have forms in parenthesis represent epenthetic vowel insertion and/or sound change rules that would apply to the cell based on the concatenation of affixes.

Indicative Class 1 paradigms (absolutive only)

	Present			Past			
	ABS	TENSE	STEM	ABS	TENSE	STEM	TENSE
1sg	*n*	*a*	*iz*	*n*	*in*	*tz*	*(e)n*
2sg	*h*	*a*	*iz*	*h*	*in*	*tz*	*(e)n*
3sg	*d*	*a*	*Ø*	*z*	*Ø*	*Ø*	*(e)n*
1pl	*g*	*a*	*ra*	*g*	*in*	*Ø*	*(e)n*
2formal	*z*	*a*	*ra*	*z*	*in*	*Ø*	*(e)n*
2pl	*z*	*a*	*rete*	*z*	*in*	*et*	*(e)n*
3pl	*d*	*i*	*ra*	*z*	*i*	*r*	*(e)n*

Indicative Class 2 paradigms (absolutive and dative)

Present

	ABS	TENSE	STEM	APL	DAT
1sg	*n*	*a*	*tza*		*it*
2sg	*h*	*a*	*tza*		*ik*
3sg	*Ø*	*Ø*	*za*		*io*
1pl	*g*	*a*	*tza*	*izk*	*igu*
2formal	*z*	*a*	*tza*	*izk*	*izue*
2pl	*z*	*a*	*tza*	*izk*	*izuete*
3pl	*Ø*	*Ø*	*za*	*izk*	*ie*

Past

	ABS	TENSE	STEM	APL	DAT	TENSE
1sg	*n*	*in*	*tza*		*it(da)*	*n*
2sg	*h*	*in*	*tza*		*ik(a)*	*n*
3sg	*z*	*Ø*	*tza*		*io*	*n*
1pl	*g*	*in*	*tza*	*izk*	*igu*	*n*
2formal	*z*	*in*	*tza*	*izk*	*izue*	*n*
2pl	*z*	*in*	*tza*	*izk*	*izuete*	*n*
3pl	*z*	*i*	*tza*	*izk*	*ie*	*n*

Indicative Class 3 Paradigms (absolutive and ergative)

Present

	ABS	TENSE	STEM	ERG
1sg	*n*	*a*	*u*	*t*
2sg	*h*	*a*	*u*	*k*
3sg	*d*	*Ø*	*u*	*Ø*
1pl	*g*	*a*	*itu*	*gu*
2formal	*z*	*a*	*itu*	*zu*
2pl	*z*	*a*	*ituzte*	*zue*
3pl	*d*	*Ø*	*itu*	*te*

Past

	ABS	TENSE	STEM	ERG	TENSE
1sg	*n*	*ind*	*u*	*t(da)*	*n*
2sg	*h*	*ind*	*u*	*k(a)*	*n*
3sg	--	--	--	*Ø*	--
1pl	*g*	*int*	*u*	*gu*	*n*
2formal	*z*	*int*	*u*	*zue*	*n*
2pl	*z*	*int*	*uzte*	*zuete*	*n*
3pl	--	--	--	*te*	--

Note that in the past tense forms of Class 3 auxiliaries, cells in the 3rd person rows have been filled with '--'. This represents the fact that for Class 3 auxiliaries, the presence of a 3rd person absolutive argument results in the case prefix agreeing with the ergative argument and a lack of absolutive agreement or ergative agreement suffix:

Past with 3rd person absolutive

	ERG	TENSE	STEM	TENSE
1sg	*n*	*Ø*	*u*	*n*
2sg	*h*	*Ø*	*u*	*n*
3sg	*z*	*Ø*	*u*	*n*
1pl	*g*	*en*	*u*	*n*
2formal	*z*	*en*	*u*	*n*
2pl	*z*	*en*	*uzte*	*n*
3pl	*z*	*Ø*	*ituzte*	*n*

Indicative Class 4 paradigms (absolutive, ergative, and dative)

Present

	ABS	STEM	APL	DAT	ERG
1sg				*it(da)*	*t*
2sg				*ik(a)*	*n*
3sg	*d*	*Ø*		*io*	*Ø*
1pl				*igu*	*gu*
2formal				*izue*	*zu*
2pl				*izuete*	*zue*
3pl	*d*	*Ø*	*izk*	*ie*	*te*

Past

	ERG	TENSE	STEM	APL	DAT	TENSE
1sg	*n*	*Ø*	*Ø*		*it(da)*	*n*
2sg	*h*	*Ø*	*Ø*		*ik(a)*	*n*
3sg	*z*	*Ø*	*Ø*		*io*	*n*
1pl	*g*	*en*	*Ø*	*(izk)*	*igu*	*n*
2formal	*z*	*en*	*Ø*		*izue*	*n*
2pl	*z*	*en*	*Ø*		*izuete*	*n*
3pl	*z*	*Ø*	*Ø*		*ie*	*n*

There are restrictions on the types of absolutive arguments that can be used in this type of construction. Specifically, absolutive arguments in this construction must be 3rd person. This accounts for the empty cells in the ABS and STEM columns. Note that in the past tense paradigm, the APL column applies when the absolutive argument is plural.

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