

DEMENTIA AND GRAMMAR IN A POLYSYNTHETIC LANGUAGE: AN ARAPAHO CASE STUDY

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In dementia in inflecting and agglutinating languages, morphosyntax is much better preserved than lexical access or pragmatics, but little is known about how dementia affects language in polysynthetic agglutinating languages with their complex verb morphology. Fortuitously, a series of narratives by a skilled Arapaho storyteller includes sessions from late in his life, when he was evidently dementing. Verb forms and clausal connectors in the speaker's Arapaho predementia and dementia narratives were sorted computationally and analyzed statistically. We found a decline in subordination and an increase in utterances missing verbs. There was a shift from using transitive active verb forms toward impersonal and passive verb forms, which require less pragmatic and syntactic computation to deploy, and a shift in subordination markers away from those requiring explicit consideration of the temporal relations between clauses.

Keywords: dementia, polysynthetic language, grammar, Arapaho, cognition, Native American languages, narrative

1. INTRODUCTION. Many studies have been done on the effects of aging-related dementias on spoken language production. Most studies of conversation and narrative have found that what is impaired is access to the lexicon and discourse pragmatics, including coherence, relevance, and clear referents for pronouns, while morphology and syntax are reported to be (relatively) unimpaired in discourse (e.g. Murdoch et al. 1987). To the best of our knowledge, however, all of the languages in which dementia has been studied to date belong to only two of the four basic (morphological) typological groups: inflectional and agglutinating. Data on dementing language from isolating languages are likely to become available in the near future. Arapaho, however, is a polysynthetic agglutinating language, and to the best of our knowledge, nothing has been published on dementia or other neurogenic disorders in such languages.

Polysynthetic agglutinating languages have very extensive and clear systems of suffixes and prefixes for deriving transitive, passive, intransitive, impersonal, reflexive, reciprocal, and other secondary stems from each basic verb root. 'Polysynthetic' means that they incorporate many of what we would consider grammatical objects, goals, and instruments into the verb, so that a single word may be the equivalent of a multiword sentence in an inflectional language (see examples below). Algonquian languages in particular, like Arapaho, also mark person and number in a way that is completely different from those used in the more familiar types of languages. In this article, we present information on the effects of dementia in a native speaker of Arapaho, a polysynthetic agglutinating language of the Algonquian family spoken in Wyoming and Oklahoma of the United States of America. We hope that this example will stimulate linguists working with typologically interesting languages to search out dementing speakers and compare their language with that of cognitively normal speakers, and also that it will caution linguists about the ways that possible cognitive decline might reduce the reliability of the language information obtained from elderly consultants.

1.1. REVIEW OF LANGUAGE IN DEMENTIA: ARE THERE MORPHOSYNTACTIC PROBLEMS? The discourse-level linguistic effects of dementia of the Alzheimer's type include limited vocabulary and frequent word-finding problems, difficulty with topic maintenance, and reduced coherence and cohesion (Bayles 1985, Kempler 1991, Dijkstra et al. 2004), as well as a decline in grammatical complexity (Kempler et al. 2001). The pattern of

these deficits depends on the type and severity of dementia. Impairments of semantic, episodic, and working memory are believed to underlie many of the discourse deficits that occur with dementias of the Alzheimer's type (Bayles et al. 1990, Salmon et al. 1991, Kempler et al. 1995). Patients with frontotemporal dementia have comprehension deficits under test conditions (e.g. Cooke et al. 2003), although problems with morphosyntax have not been reported.

However, in an early study of speech from patients with dementia (probably French-speaking; the paper is translated from French), Constantinidis and colleagues (1978:129) state, without giving examples, that:

language ... becomes elliptic and pleonastic. Prepositions are left hanging without the nouns or phrases which should follow them, terms which are essential to the situation are omitted. Predicates are multiplied ... Lack of the right word ... seems to be momentarily remedied by the use of common paraphrases ... morphosyntactic linguistic values ... are preserved for a very long time within the framework of more or less automatic verbal utterances.

Irigaray (1967) found an 'absence of organization' in the utterances of people with dementia that 'could end up as utterances consisting of simple strings of words', as well as the expected problems with coherence, reference, and anomia—and, interestingly, an 'absence of distress' about their word-finding problems. In testing, she found lexical and structural perseveration, but only in the most severely affected patients did Irigaray find morphosyntactic failures, specifically, syntactic incoherence when patients were asked to orally complete sentences that she started with a short phrase (prompt in roman, patient completion in italics).

- (1) Il me semble que *pour lire*.
'It seems to me that *for reading*.'
- (2) Je vous donne un *d'aller chercher quelque chose*.
'I give you a *to go get something*.'

Errors of gender and number agreement were also found when patients were asked to start off a sentence that could end with a given phrase. (The difference between masculine singular and plural forms *gentil/gentils* exists only in spelling, not in the pronunciation of the word.)

- (3) *Des fleurs* (fem.pl.) parait (3sg.) très gentil(s) (masc.sg/pl.).
'*Some flowers* would be very nice.'
- (4) *Une personne* (fem.sg.) parait très gentil(s) (masc.sg/pl.).
'*A person* would be very nice.'

In all of these examples from Irigaray, however, one may wonder whether the patient had any understanding of the elicitation task. Finally, Meteyard and Patterson (2009) have found morphological errors in narratives of patients with semantic dementia, which is classed as a type of PRIMARY PROGRESSIVE APHASIA.

In experimental studies of English (Altmann et al. 2001) and of Greek (Fyndanis et al. 2013), problems with grammatical morphemes in mild probable Alzheimer's disease have been found, although there are again some questions as to whether these problems are truly syntactic (Kavé & Levy 2003), or whether they are a consequence of difficulty with the overall task demands; see Almor et al. 2001. Indications of other difficulties in syntactic processing have also been reported in dementia of the Alzheimer's type (e.g. Price & Grossman 2005). Finnish investigators (Kontiola et al. 1990:378) state that:

difficulties in understanding and constructing complex grammatical structures are typically associated with [Alzheimer's disease] ... The deterioration in language functions found in mild dementia can be at-

tributed to a great extent to general intellectual impairment and to memory disorders on the basis of the task complexity. The basic language functions seemed to preserve quite intact in mild dementia.

Kontiola and colleagues found similar deficits in multi-infarct dementia (dementia caused by numerous small obstructions to cerebral blood flow), but were able to differentiate the patient groups statistically: the patients with multi-infarct dementia showed greater deficits in word recognition, naming, and repetition. There was no indication of difficulty with basic morphosyntax for either Finnish patient group.

In summary, morphology and syntax are relatively preserved in the discourse of patients with dementia, but experimental studies have shown deficits, which may be primary or secondary to the effort of complying with task demands. Given that even normal speakers may show agrammatic performance under sufficient task stress (Blackwell & Bates 1995), the issue of whether the experimentally found morphosyntactic deficits are primary in any or all of the dementias may be impossible to resolve.

1.2. THE PRESENT CASE AS A ‘TARGET OF OPPORTUNITY’. The Arapaho speaker, whom we call ‘Phil’ here, is deceased. There was no medical diagnosis or documentation of his cognitive decline, but the family’s reports of his language and his behavior—specifically, his memory impairments—support a provisional diagnosis of some type of dementia, most likely Alzheimer’s disease, semantic (frontotemporal) dementia, or multi-infarct dementia. Because he was bilingual in Arapaho and English and recordings were made over a considerable timespan in both languages, if we analyze and compare his speech in both languages, we can see that his discourse was indeed characterized by features of some type of dementia (as shown below). As author AC was initially working with the Arapaho data from the period of dementia, his impression was that subordination was much reduced in Phil’s narratives, and that there were large numbers of a particular simple type of verb. These informal observations were the starting point for this case study.

Although this study has only a limited amount of behavioral evidence about Phil’s dementia and no formal neurological or behavioral information, recordings of both his premorbid and dementing language data are reasonably extensive because he was known in his prime as a skilled storyteller, dedicated to the preservation of Arapaho language and culture. These recordings permit statistical as well as descriptive analysis. We show that there are noticeable effects of Phil’s dementia on his morphosyntax in the production of the types of narratives that he was familiar with. Specifically, there is a major simplifying shift in the kinds of verb forms that he uses and a reduction in his use of relative and other subordinate clauses. Since there is no other neurolinguistic study of a polysynthetic agglutinating language, the present work should at least serve as an example of why neurogenic disorders in languages of this type are well worth studying.

1.3. THE ARAPAHO LANGUAGE. Arapaho is a member of the Algonquian language family, spoken primarily in Wyoming at this point. It is an endangered language, with the number of speakers in the low hundreds. The grammar of Arapaho is described in detail in Cowell & Moss 2008. The apostrophe in the transcriptions below follows the orthography used by that grammar and by the tribe; it represents a glottal stop. As in all Algonquian languages, both noun and verb stems normally take a number of prefixes, suffixes, and proclitics. For nouns, these indicate things such as adjectival modification or possession (prefixes) and number, locative function, diminutive, or case (suffixes). For verbs, the prefixes serve to indicate tense, aspect, instrumental relations, adverbial modification, auxiliary-type verbal modification, subordinate relations, and sometimes person, while suffixes indicate person, number, case agreement, and some aspectual or

modal functions. It is not uncommon for verbs to have three or more prefixes and two suffixes when used in discourse.

The noun stems and verb stems themselves can be quite complex internally, having initial, medial, and final elements. Many secondary derivational suffixes can be added to the already-complex stems to create passive, causative, benefactive, goal-oriented, diminutive, and other verbal forms, as well as agentive or undergoer nominal forms. Reduplication of verb stems is used extensively to indicate repeated, distributed, or extended action, for example, *cebisee-* 'to walk past', *ceecebisee-* 'to walk back and forth past'. Verb stems can incorporate their grammatical objects, for example, *hoxow-ooxob-ei-* 'to feed horses' vs. *benoh-ooxob-ei-* 'to water horses', *tow-oon-ee-* 'to have a broken leg' vs. *tow-ookut-ee-* 'to have a broken tooth'; topics or classificatory medial forms, for example, *tei'-oowu-* 'to be strong (water, liquid)' vs. *tei'-oxoehi-* 'to be strong (wood)' vs. *tei'-ooceihi-* 'to be strong (rope or rope-like object)'; and manner or means of action and other categories, for example, *seyou-n-* 'to crush by hand' vs. *seyou-'on-* 'to crush by foot' vs. *seyou-θeih-* 'to crush by means of a hard object'.

Finally, Arapaho has free word order, with actual order in discourse determined by pragmatic salience. Both subjects and objects can be omitted if they are clear in context. This property of the language, combined with its tendency to make objects, instruments, adverbs, and other elements into affixes of the verb, means that Arapaho clauses often contain no overt nouns or pronouns. A quite normal Arapaho two-clause, two-word sentence is shown in 5.¹

- (5) Wootooyei-no'usee-n-inchk, heet-won-oon-otoonee-no'.
 early-arrive-2SG-SUBJ FUT-go.to-REDUP-buy.things-1PL.INCL
 'If you get here early, we will go around shopping (various places).'

2. HYPOTHESES REGARDING THE IMPACT OF DEMENTIA ON ARAPAHO. Our central hypothesis is that the complexity of linguistically expressed relationships among participants and events in narratives will show a decline in dementia. This decline will be evident and measurable in Arapaho, appearing even in the areas of morphology and morphosyntax because it is a polysynthetic agglutinating language. Arapaho verbal morphology, in particular, is quite complex: relationships between participants in a narrative are indicated primarily by pronominal affixes attached to the verb, which indicate person (first, second, third), number (singular, plural, exclusive, inclusive), saliency (primary or 'proximate' third person vs. secondary or 'obviative' third persons), and grammatical roles (actor, undergoer, etc.). Relationships between events in a narrative are also indicated by verbal affixes, which indicate tense, aspect, modality, subordination, and other features.

Our hypotheses focus on two areas, subordination (event relationships) and use of transitive verbs, which require at least two different inflectional affixes in order to show who is doing what to whom.

2.1. SUBORDINATION. The first hypothesis is that subordination will decline in general, being replaced by series of independent clauses simply strung together consecutively, as in English 'and then ... and then ... and ... and then ...'. Arapaho has several subordi-

¹ Abbreviations used are as follows: ADV: adverb, DEPART: dependent participle, DETACH: derivational detachment suffix, EXCL: exclusive, FUT: future, IC: initial change, IMPF: imperfect, INCL: inclusive, INST: instrumental, IRREAL: irrealis, OBV: obviative, PL: plural, PST: past, REDUP: reduplication, SG: singular, SUBJ: subjunctive.

nating prefixes (Cowell & Moss 2008:286), which indicate a variety of logical as well as temporal relationships between clauses. They include the following, among others.

- (6) Subordinating prefixes
tih- ‘when’ (background to main action)
toh- ‘when, after, because’ (logically necessary and temporally prior to subsequent action)
hei’- ‘when, once’ (perfective, temporally prior to subsequent action)
heetih- ‘so that, in order that’ (logically necessary for subsequent action)

Arapaho also uses inflectional suffixes to indicate other types of temporal and logical subordination. The key ones (ignoring various allomorphs) are given in 7.

- (7) Inflectional suffixes
-(C)i iterative mode (‘whenever ... ’)
-ehk/-hek subjunctive mode (‘if ... ’ or ‘when ... (in future)’)

Finally, Arapaho also makes use of noun-forming processes to create relative clauses, taking a verb such as that in 8 and creating a possessed noun known as a ‘dependent participle’, as in 9.

- (8) *niihiθ-eθen*
 IC.say.something.to.someone-1SG/2SG
 ‘I have said it to you’
 (9) *he-niihiθ-eθeet*
 2SG-say.something.to.someone-1SG.DEPPART
 ‘the thing that I said to you’

These different subordination markers are separately labeled in the textual database of Phil’s narratives, so they can be counted individually and also summed computationally. A count of the total number of occurrences of these verbal prefixes, suffixes, and dependent participle forms in a narrative is effectively a count of the number of subordinate clauses of the above types in a narrative. There are other possible subordination prefixes and strategies, but the ones listed are widespread enough to produce fairly high counts in terms of tokens. Our first hypothesis, then, is that total counts of the listed subordination markers will decline.

A second, more specific, hypothesis is that among the prefixes, the usage of *tih-*, which merely indicates states or actions that are background to a main event, will decline the least. Sentences such as that in 10 require no complex logical or temporal relationship between the two clauses.

- (10) *Tih-wooneihi-noo, nih-’iteθebiibi-noo.*
 when-young-1SG PST-possess.dog-1SG
 ‘When I was young, I had a dog.’

By contrast, usage of forms such as *toh-* ‘after’ and *heetih-* ‘in order that’ does require computation, so to speak, of necessary logical and temporal relationships between events, and thus between clauses.

- (11) *Toh-no’usee-t nih-’iinikotii-ni’.*
 when/after-arrive-3SG PST-play-1PL.EXCL
 ‘After he arrived, we played together.’

Thus subordination using verbal prefixes other than *tih-* would be expected to decline by a greater amount than prefix-based subordination generally.

2.2. PARTICIPANT RELATIONSHIPS. Our second area of focus is participant relationships (argument structure, thematic relations). The most complex way of expressing

participant relationships in Arapaho is to use TRANSITIVE ANIMATE (TA) verb stems, which involve two animate arguments and require marking of at least two participants on the verb. A third participant may also be included lexically in the verb (as in 13), or be marked on it.

(12) Nih-to'ob-**eθe-n**.

PST-hit.someone-1SG>2-2SG

'I hit you.'

(13) Heet-biin-**eθe-nee**.

FUT-give.something.to.someone-1SG>2-2PL

'I will give it to you (pl).'

Strictly speaking, these inflections do not actually index an 'actor' and an 'undergoer', nor do they directly index subject and direct object. Instead, the higher-ranked participant is marked directly, based on a person hierarchy of 2-1SG-3-1PL-4-0 (4 = less prominent third person; 0 = inanimate). In other words, whichever participant ranks higher will be indexed via an inflectional suffix on the verb (with a few minor irregularities), regardless of whether that participant is subject or object, agent or undergoer. 'Fourth person' (obviative) refers to a pragmatic category: when two or more third persons are involved in a discourse, one is selected as more salient. This is the 'proximate' participant. All other participants are marked inflectionally as less salient, and these are the 'obviative' participant(s) (see Cowell & Moss 2008:349-52). In a narrative, the proximate third-person suffix refers to, roughly, the protagonist, while fourth person refers to 'the other guy(s)' as opposed to the protagonist.

'Direction-of-action' or 'theme' morphemes, which occur between the verb stem and the inflectional suffix, are then used to disambiguate who is the actor and who is the undergoer. These theme morphemes are given in 14.

(14) Theme morphemes

-i- 2 acting on 1SG (2>1SG)

-eθe- 1SG acting on 2 (1SG>2)

-ei'ee- 2 or 3 acting on 1PL (2 or 3>1PL)

-ee- 1PL acting on 2 or 3 (1PL>2 or 3)

-oo- 1 or 2 acting on 3, or 3 acting on 4

-ei- 3 acting on 1 or 2, or 4 acting on 3

Due to the rules of the person hierarchy, any second-person participant will always be marked on the verb, whether that person is subject, object, agent, or patient. The direction-of-action markers then indicate whether that person is actor or undergoer.

(15) beniinin

beniin-i-n

(underlying form)

IC.give-2>1SG-2SG

'you have given it to me'

(adapted from Cowell & Moss 2008)

(16) beniineθen

beniin-eθe-n

(underlying form)

IC.give-1SG>2-2SG

'I have given it to you'

(adapted from Cowell & Moss 2008)

In contrast, Arapaho intransitive (AI) verb stems mark only one participant on the verb, normally the actor.

(17) Nih-nihi'koohu-**noo**.

PST-run-1SG

'I ran.'

The suffixes for AI stems are listed in 18. The notation ‘12’ refers to first-person plural inclusive (i.e. we/us = the speaker and the person(s) spoken to), while ‘1PL’ refers to first-person plural exclusive (i.e. we/us = the speaker and someone else, excluding the person(s) spoken to).

(18) AI stem suffixes

	SG	PL
1	-noo	-ni’
12	—	-no’
2	-n	-nee
3	-t	-θi’
4	-niθ	-niθi

Transitive Arapaho verb stems in which the action involved affects an inanimate object (TI) have inflections similar to those for intransitive verbs: while both the inanimate object (marked as ‘0’ in the interlinear morphemic gloss) and the animate actor are marked on the verb, the marker for the inanimate object remains largely invariable.

(19) Nih-to’oot-**owu-nee**.

PST-hit.something-0-2PL

‘You (pl.) hit it.’

(20) Nih-to’oot-**owu-no’**.

PST-hit.something-0-1PL.INCL

‘We hit it.’

Simplest of all are intransitive verbs involving inanimate subjects (II), which mark only number.

(21) bee’ee-’

‘it is red’

(22) bee’ei-’i

‘they are red’

Our second main hypothesis is that the ability to perform complex tracking of multiple participant relationships in narrative will diminish due to dementia. This will be observable and measurable by a decline in the number of TA verb tokens, and also by a decline in the number of different discrete TA verb stems—that is, these types of verbs will be used less often, and the range of different TA lexical items will also become restricted. As a corollary, we hypothesize that an increasingly small number of lexical TA verbs will come to dominate TA usage to the extent that it does occur: that is, the ratio of stems to tokens will get smaller and smaller, as only a few common, easily recallable TA verb stems will be used. Finally, we hypothesize that the range of different inflectional patterns used on the TA verb stems will decrease; in other words, rather than rich sets of shifting inflections such as ‘he Verb me’, ‘we Verb them’, ‘they Verb us’, we will find inflections increasingly dominated by a few very common forms (‘he Verb him’, ‘I Verb him’).

Of course, there are still potentially multiple participants in a narrative, so the question is how the speaker could still tell the narrative while using many fewer TA verbs. As a complementary hypothesis to the preceding set, we suggest that he will use a number of derived verb forms. Certain derivations turn TA verbs into AI (passive) verbs or II verbs, thus drastically reducing the inflectional complexity needed for deploying the verbs in production. Using these AI or II forms is thus essentially a strategy for avoiding the larger inflectional paradigms and the complex pragmatic-morphosyntactic computations required for choosing the correct forms within those paradigms.

Specifically, we expect some of the three following avoidance strategies to be used. The first is the use of unspecified subject verbs, or ‘impersonal verbs’ (Cowell & Moss 2008:194–95). In Arapaho, such verbs are in a certain sense more complex than normal transitive or intransitive verbs, in that the verb stem is secondarily derived.

(23) Impersonal verbs

<i>noohoot-</i> (TI)	‘see something’	>	<i>noohooθootiini-</i> (II.IMPERS)	‘people see something/things’
<i>nokohu-</i> (AI)	‘sleep’	>	<i>nokohuutooni-</i> (II.IMPERS)	‘people are sleeping’
<i>niiteheib-</i> (TA)	‘help someone’	>	<i>niiteheibetiitoooni-</i> (II.IMPERS)	‘people are helping each other’

We do not go into the details of the derivation here, since we simply want to illustrate the nature of the process. While it seems complex, it has two advantages in terms of avoidance. First, the resulting verb is intransitive, no matter what the valence of the initial verb, so this reduces the number of inflections from two to one. Second, the resulting verb is grammatically inanimate (type II); furthermore, impersonal verbs only allow the singular ending, so there is no inflectional choice whatsoever. Thus, for example, rather than a choice of nine possible AI suffixes, the speaker has one II choice, which is predetermined. Furthermore, impersonal verb stems are common in Arapaho.

The second potential strategy is to use unspecified object verbs, or ‘indefinite object’ (AI.O) verbs (Cowell & Moss 2008:364–66). These are AI verbs, which allow one to avoid the inflectionally demanding TA verbs. They are actually directly derived from TI verbs, rather than TA verbs, but can be used to replace the transitive type of verb with an intransitive.

(24) Indefinite object verbs

<i>noohoot-</i> (TI)	‘see something’	>	<i>noohooθei-</i> (AI.O)	‘see (unspecified) things’
<i>ni'eeneet-</i> (TI)	‘like something’	>	<i>ni'eeneeθei-</i> (AI.O)	‘like (unspecified) things’

Here again, although the secondary derivation process seems to increase the complexity of the verb, the end result is a reduction from two inflectional suffixes to one.

A third key strategy is passivization. This also reduces the number of arguments of a verb from two to one. Once again, in Arapaho, this involves secondary derivation on the verb stem (Cowell & Moss 2008:151–56), and thus an increase in derivational grammatical complexity.

(25) Passive verbs

<i>noohob-</i> (TA)	‘see someone’	>	<i>noohobeihi-</i> (AI.PASS)	‘seen (by someone), visible’
<i>to'ob-</i> (TA)	‘hit someone’	>	<i>to'obeihi-</i> (AI.PASS)	‘hit (by someone)’

However, we again hypothesized that the greatly reduced number of inflectional choices compensates for the increased derivational complexity of these forms. There are also II passive forms: *noohobeihi-* > *noohobeihiinoo-* (II.PASS) ‘seen, visible’.

In summary, all three of the secondary derivational processes described here increase the complexity of the verb stem, but reduce inflectional complexity. In addition, all three processes are extremely common, extremely regular, and predictable in Arapaho. We suggest that because of their frequency (and despite their transparency), the so-called ‘secondarily derived’ verb stems (or at least those for frequently used verbs)

should actually be considered lexical forms from the standpoint of speaker production, rather than being forms created and derived on-line. Our hypothesis is thus that the incidence of the types of forms described in this section should increase in narratives from the period of dementia, at the expense of TA verbs. (Due to problems in the way the database is labeled, we were not able to count the indefinite object verbs for this study, but we have counted impersonal (indefinite subject) and passive verbs, as both types are labeled in the database and thus easily countable computationally.)

3. METHODS. The consultant, 'Phil', lived his entire life (1911–1995) on the Wind River Reservation in Wyoming. He was raised as a monolingual speaker of Arapaho, although he learned English (Native American Vernacular English (NAVE), an ethnically based variety of English, sometimes called 'Red English') once he went to school. As mentioned above, he was strongly invested in the preservation and transmission of his language and culture, and was known as a very good and very knowledgeable storyteller. He raised his own children as monolingual speakers of Arapaho in the 1930s and 1940s, and they likewise learned English only when they went to school. Phil was thus bilingual in Arapaho and NAVE, but he was Arapaho-dominant for most of his life and continued to speak Arapaho daily with his children as well as friends and relatives of his own age until he passed away. Community language shift from Arapaho to English began in the late 1940s and 1950s. NAVE became increasingly prevalent after this time, primarily among younger Arapahos and between the parent and child generations, even as older Arapahos of the parent and grandparent generations continued using Arapaho among themselves. Currently, the youngest fluent native speakers of the language were born in the early 1950s.

The data in this article come from Phil's oral narratives, which were recorded on videotape and audiotape by his family members. The performances of the narratives were done both for the benefit of the family and other friends and relatives who might have been present, and explicitly for the purpose of preserving the particular narratives in question. Because his family was aware of the community's language shift, Phil was asked to provide narratives in both English and Arapaho, and we have access to some individual narratives that he told in both languages.

3.1. EVIDENCE FOR DEMENTIA. The diagnosis of dementia is not straightforward, and dementia may be related to a number of different underlying medical conditions. Because Phil passed away prior to our work with Arapaho, we had no opportunity to interact with him personally or carry out diagnostic testing. Our provisional diagnosis of Alzheimer's disease, semantic (frontotemporal) dementia, or multi-infarct dementia is based on two sources: family reports of his medical condition, and examination of the speaker's audio- and videotapes. Unfortunately, since he passed away over twenty years ago, his primary caregivers and his children also are all now deceased, so there was no opportunity to use a dementia questionnaire with them once the idea for this article arose.

No strokes were reported or evident to the family or on videotape, and there were no audible speech impairments. There was no sudden or dramatic shift in his condition—either physically or neurologically—over the last years of his life, so far as his children could recall, but rather a slow, progressive decline. He was described as becoming increasingly forgetful and easily confused, not being able to stay focused on a topic when he talked, unable to think of the words he needed, being so vague that family members were sometimes not sure what he was talking about, repeating himself often, and tending to ramble and switch abruptly from topic to topic. He had increasing difficulty following others' talk for long periods, maintaining attention on what others were saying,

and even sometimes understanding basic commands or requests. When he was asked by family members in the 1990s about a few obscure and probably archaic words from his earlier (1980s) video recordings (when he showed no signs of dementia), he responded that he had never said anything like that; when the section of the tape was played for him, he did not understand or recognize what he had once said. In the most colloquial terms, he was described by a family member as having ‘kinda lost his marbles there at the end’. Phil died of progressive heart failure in 1995.

The following English passage is from an interview recorded with Phil in 1994. Although the speech genre is quite different from the oral narratives to be considered in the body of this article, we provide it as linguistic evidence for the speaker’s dementia. Note the very loose chaining of topics: Phil drifts from a response to the initial question about giving names, to how he was compensated for giving names, then to his general role as a preserver of oral traditions and his compensation for that, and so on; the end of the passage stays on the topic of the loss of traditions, but the phrasing is vague and repetitive. Also note the large number of pronouns without clear referents (e.g. ‘I gave **it** to my daughter’; ‘Sometimes **it**’s gone, it leaves’; ‘I got **that**’), despite the presence of six proper names in the first half of the passage. Items in {braces} have been added for clarity. Personal names have been replaced by capital letters in square brackets.

(26) Interviewer: Have you given lots of names to babies?

Phil: Yeah. From ... a ... [A]’s ... a ... grandson, [B]’s boy, [C] ... little boy. Eagle Chief. ‘First chance you gonna make it over, we’re gonna cook for you.’ Which is traditional. Like over here, where I gave that baby a name. Yeah. They cook for me over there and gave me things. Whatever they give ... had to give without being hurt. They gave me covers and some money. And I don’t ask them, it’s gotta come from here. Yeah. No lie. I gave it to my daughter [D], I gave it to my granddaughter [E]. All those things, just pass on, blessing, it come back. Yeah. Those things that I acquired going through this here {= annual sundance ceremony}. And, they tell me, ‘Come, we’re gonna bless you. Open your mouth, you’re gonna sing.’ Like that. I got that. Composed a lot of songs. Sun Dance songs. Those things there that I acquired from inside there. My singing. I was given a drumstick. Plume. Whistle. Yeah. I got a lot of things from inside that {sundance}. [F], the old man, yeah, gave me a stone. ‘You remember me.’ Sometimes it’s gone, it leaves, I don’t know where it goes, then it come back. I go that ... hey, I finally look at my shirt, it was sitting there. I put it back where it belonged. It left again, when I went to visit the hospital. I don’t know. One of my grandchildren might have it. I don’t know. I don’t ask ... I don’t know about that. All those things that come from back there [in the past]. Tecumseh, Ottawa chief. Yeah. Algonquians acquire. Those things meant a whole lot. Sage. The sage tie. You get four of ... you tie on to your staff. Four songs. For the drum, just four. But they don’t do that anymore. When I was there, 1935, they sing four songs. One song, they sing it four times, yeah, then the next song, four times. The next one ... four ... sixteen {content suggests that he is now talking about the peyote ceremony of the Native American Church}. And the fifth one. Set of four, four songs. Go long time. Lot of time these singers, they ... they lose their song. Go ahead and sing it again, same one, sing it again. They got so they could just ... they just sing two ... one song two times now. Long time now ...

Interviewer: We’re done now, Phil.

This English passage presents evidence for basically all of the classic pragmatic problems associated with the language typically reported in various dementias in English speakers. It also has hints of unexpected grammatical problems, even in English: (i) breakdown of syntactic structure and its replacement by simple nominal collocation: *Tecumseh, Ottawa chief; The next one ... four ... sixteen. And the fifth one. Set of four, four songs*; (ii) breakdown of noun/verb agreement, argument structure, and tense and aspect structure: *Go long time; Algonquians acquire*. The pauses in this passage may indicate searches not only for a vocabulary item, but possibly also for the correct grammatical structure into which to insert vocabulary.

Because the English shows typical features of dementing language, we can assume that the Arapaho data show what can happen to language in dementia in Arapaho and typologically similar languages. While the English evidence for a grammatical deficit is marginal, as is to be expected, the Arapaho data will be more convincing. We suggest that the greater prominence of morphosyntactic problems in Arapaho than in English is due to the typological difference between Arapaho and English: in polysynthetic languages, pragmatic considerations have stronger and more direct effects on morphosyntax than they do in the inflecting languages with which most of us are more familiar. So Phil's deficit, which is manifested in English with major pragmatic but only modest morphosyntactic problems, creates serious limitations in both pragmatics and morphosyntax in Arapaho.

Finally, we have compared data from Phil to some data from his son (see Table 6 below). Unfortunately, no similar narratives were recorded from speakers of Phil's age from the 1970s to 1990s, so direct comparison to peers is not possible. The recordings we have from his son are from 2003. The son was born in 1933, so he was seventy years old when he was recorded, roughly the same age as his father when he was recorded in 1979–1982. Arapaho is an endangered language, however, and language shift makes it difficult to compare across generations with a great deal of confidence (Dorian 1989). The narratives told by his son are all somewhat shorter as well, and not necessarily of exactly the same genre. Nevertheless, this does provide some comparative data from a second speaker whom we would expect to speak a variety of Arapaho very similar to Phil's in many ways.

3.2. ARAPAHO DATABASE. The data used here are drawn from a database of natural discourse (both single-speaker narrative and conversations) that documents over fifty speakers of Arapaho; it includes tens of thousands of lines of data, primarily on video, but with earlier material on audio. The Arapaho data have time-aligned transcriptions and translations, along with interlinear grammatical analysis, done by first author AC working with native-speaker consultants. Five long (thirty minutes or more) texts, all from Phil, were used in this analysis. The texts are traditional and/or historical narratives, with ethnographic commentary included at the ends, and all are told in Arapaho, with occasional English words interspersed as glosses. The entirety of all five texts was used in the analysis, excluding the words in English. Four of the texts were originally audio-recorded by the son of the speaker, and one was audio-recorded by an ethnographer for a special oral history project. All five of the texts were transcribed and translated by the first author and the son of the speaker. The son was himself, as mentioned above, a native speaker of Arapaho. The one text recorded by the ethnographer is of poor sound quality; some short segments (less than 5% of the total) could not be made out and are not included in the analysis. The first three texts are from the period 1979–1982 and were used as a baseline for this analysis. The fourth text from 1989 and the fifth from 1993 were used to study the effects of the speaker's dementia.

Three texts from the speaker's son were used, which include one traditional narrative, one narrative about the reservation era, and one 'folk hero' story, also from early reservation times. They have been processed in the same way as those from Phil. AC worked with Phil's son personally, and there was no evidence of dementia in his case.

3.3. LABELING AND COUNTS. After the texts were transcribed and translated, interlinear annotation was done automatically with Toolbox linguistic annotation software. Annotation was done at the level of prefixes, suffixes, and noun and verb stems. Each of these elements was labeled for part of speech and transitivity and given a gloss. Thus the past-tense prefix *nih-* was labeled *PREF, PAST*; the verb *biin-* 'give something to someone' was labeled *VTA, give*; and the passive verb *biineihi-* 'to be given something by someone' was labeled *VAL.PASS, give*. Derivations such as *biin-* TA 'give' > *biineihi-* AI 'given' were counted as different verb subtypes (TA vs. AI), as well as different lexical stems, since they occurred in different subtypes. With this labeling, we are able to automatically count the number of occurrences of verbs in each text, as well as the number of occurrences of verbs of different subtypes.

Searching for individual labels permitted us to count the number of different individual lexical verbs that occurred in each text, labeled by subtype (*biin-* VTA, *give*; *noohob-* VTA, *see*; *ceh'eθih-* VTA, *listen to*, etc.). We were also able to count the number of tokens for each individual discrete verb and determine which verbs were used multiple times within a specific text. This tokens-per-verb information enabled us to measure what percentage of the total number of verbs accounted for 50% of the total tokens for a given verb subtype. So, for the 1993 text 'White Horse' there were twenty-four different individual TA verbs used, and a total of thirty-three different tokens of TA verbs. Among the twenty-four verbs, four had multiple tokens (occurred more than once), and the eight most frequent verbs out of the twenty-four different verbs was necessary to reach a total of 50% of the overall tokens of TA verbs (i.e. seventeen tokens out of the thirty-three). The percentage of the total number of verbs that accounts for 50% of the total tokens for a given verb subtype—in this case, $8/24 = 33\%$ —gives a measure of the relative lexical richness of each text: the LOWER this percentage, the MORE the text is dominated by just a few verb types.

From the raw numbers of tokens of each lexical verb of each subtype, we then calculated the percentage of each subtype of verb that occurred in each text, relative to the total number of verbs in that text, to normalize for differences in absolute numbers of verbs across texts. For tokens, we compared TA tokens to overall verb tokens, and for specific lexical verbs, we compared specific TA verbs to the overall number of verbs of all types. For the latter counts, reduplicated forms of a verb were considered to be equivalent to nonreduplicated forms (e.g. AI *heestoo-* 'what someone is doing' = AI *heeneestoo-* 'what all someone is doing/the various things someone is doing'), and imperfective/habitual forms of verbs were considered to be equivalent to ongoing forms (AI *heestoo-* 'what someone is doing' = AI *niistoo* 'what someone does habitually'). In other words, all of these were considered the same lexical item, not in the sense that they share exactly the same meaning, but in the sense that they are derived from the same basic AI form *heestoo-* in ways that do not change their valency and inflectional characteristics.

For the examination of subordination, similar procedures were followed, though there was no examination of lexical richness, since the subordinating prefixes and suffixes constitute small closed classes. The number of tokens of each subordinating prefix was counted; then the total for all such prefixes was obtained (because the small numbers of tokens for individual prefixes would have made statistical analysis meaning-

less); and finally a percentage was calculated, based on the number of tokens of the set of prefixes compared to the overall number of verb occurrences in the text (subordination is not restricted by verb type). The number of tokens of each subordinating inflectional suffix was likewise counted and converted to a percentage of the total number of subordinating inflectional suffixes.

4. RESULTS. Tables 1 and 2 show the raw data for all indices that were measured in the three baseline (predementia) and two dementia samples.

DISCOURSE FEATURES	BASELINE PREDEMENTIA				
	SAMPLE 1	SAMPLE 2	SAMPLE 3	MEAN	SD
Total # verbs	387.00	444.00	652.00	494.33	139.49
Total # verb stems	186.00	238.00	266.00	230.00	40.60
% of verbs that are TA (tokens)	23.77	26.35	18.87	23.00	3.80
% of total verb stems that are TA	24.19	20.59	16.17	20.30	4.00
% of TA stems with multiple tokens	53.33	30.61	55.81	46.60	13.90
% of verbs that are TI (tokens)	11.37	9.23	9.36	10.00	1.20
% of total verb stems that are TI	8.06	8.40	6.39	7.60	1.10
% of verbs that are II impersonal (tokens)	1.29	3.83	3.37	2.80	1.40
% of verbs that are II passive (tokens)	0.26	2.70	1.84	1.60	1.20
% of verbs that are either impersonal or passive (tokens)	1.55	6.53	5.21	4.40	2.60
% of impersonal and passive stems with multiple tokens	20.00	22.72	19.23	20.70	1.80
% of verbs that are primary II (tokens)	12.66	10.14	18.25	13.68	4.15
% of total verb stems that are primary II	14.52	13.45	17.67	15.21	2.19
% of verbs that are AI (tokens)	49.61	41.89	42.94	44.80	4.20
% of total verb stems that are AI	48.39	41.18	42.48	44.00	3.80
% of total verbs with inflectional subordination	5.94	4.95	3.99	5.00	1.00
% of total verbs with prefixal subordination	11.63	9.91	8.90	10.10	1.40
Overall % of verbs with subordination (inflectional + prefixal)	17.57	14.86	12.88	15.10	2.35

TABLE 1. Data for baseline predementia samples.

DISCOURSE FEATURES	DEMENTIA			
	SAMPLE 1 (1989)	SAMPLE 2 (1993)	MEAN	SD
Total # verbs	732.00	519.00	625.50	150.61
Total # verb stems	297.00	257.00	277.00	28.28
% of verbs that are TA (tokens)	12.57	6.36	9.47	4.39
% of total verb stems that are TA	10.77	9.34	10.06	1.01
% of TA stems with multiple tokens	28.12	16.68	22.40	8.09
% of verbs that are TI (tokens)	8.33	10.40	9.37	1.46
% of total verb stems that are TI	7.41	8.56	7.99	0.81
% of verbs that are II impersonal (tokens)	4.78	6.94	5.86	1.53
% of verbs that are II passive (tokens)	5.33	5.59	5.46	0.18
% of verbs that are either impersonal or passive (tokens)	10.11	12.52	11.32	1.70
% of impersonal and passive stems with multiple tokens	41.86	44.83	43.35	2.10
% of verbs that are primary II (tokens)	25.27	17.53	21.40	5.47
% of total verb stems that are primary II	20.20	16.73	18.47	2.45
% of verbs that are AI (tokens)	39.48	40.85	40.17	0.97
% of total verb stems that are AI	40.07	42.02	41.05	1.38
% of total verbs with inflectional subordination	2.87	2.50	2.69	0.26
% of total verbs with prefixal subordination	7.10	4.05	5.58	2.16
Overall % of verbs with subordination (inflectional + prefixal)	9.97	6.55	8.26	2.42

TABLE 2. Data for dementia samples.

The stability in measures of the data gathered during the baseline phase was mixed. Some measures (e.g. percentage of AI tokens, percentage of AI stems, and percentage of stems with multiple tokens) were quite stable over the three baseline samples, while others (e.g. percentage of passive tokens and percentage of impersonal tokens) varied greatly. The standard deviation (*SD*) for ten of the fifteen measures was 20% or less of the mean (see Table 1). The stability of these ten measures at baseline makes it more likely that significant differences can be reliably detected when compared to the data collected in the dementia phase.

There is no agreed-upon method for analyzing differences in a limited amount of data collected from a single participant at two different points in time. Therefore, we chose to analyze this data set using three analysis methods (visual inspection, *t*-test, and effect size Cohen's *d*). The criteria for significant differences were then considered to be satisfied when at least two of the three methods suggested a difference. When using visual analysis, the important feature is nonoverlapping data points from the two time periods (baseline and dementia phase). As can be seen in Table 3, nine of the eighteen measures had no overlap between baseline and dementia phases.

Sixteen of eighteen measures had Cohen's *d* values of 0.8 or larger. These are considered 'large' effect sizes, which means that the mean for the dementia phase was at the ± 79 th percentile of the baseline mean. The nine measures that had no overlap of data points also met our criteria for significant difference. Finally, six measures had *p*-values of 0.10 or smaller when analyzed with a *t*-test. *T*-test results combined with visual inspection and effect size (Cohen's *d*) did not result in the identification of any additional measures. However, there were five measures that met levels of significance on all three analysis methods. This suggests greater confidence that baseline-to-dementia differences for these five measures are truly different.

DISCOURSE FEATURES	VISUAL INSPECTION	<i>t</i> -TEST (<i>p</i> -VALUE)	COHEN'S <i>d</i>
% of impersonal and passive stems with multiple tokens	no overlap	0.004	11.58
% of verbs that are II passive (tokens)	no overlap	0.17	4.50
% of total verb stems that are TA	no overlap	0.06	3.51
% of verbs that are TA (tokens)	no overlap	0.18	3.30
% of total verbs with inflectional subordination	no overlap	0.07	3.16
% of verbs that are either impersonal or passive (tokens)	no overlap	0.11	3.15
Overall % of verbs with subordination (inflectional + prefixal)	no overlap	0.03	2.87
% of total verbs with prefixal subordination	no overlap	0.08	2.48
% of verbs that are II impersonal (tokens)	no overlap	0.04	2.09
% of TA stems with multiple tokens	overlap	0.18	2.13
% of verbs that are primary II (tokens)	overlap	0.16	1.59
% of total verb stems that are primary II	overlap	0.17	1.40
Total # verb stems	overlap	0.39	1.34
% of verbs that are AI (tokens)	overlap	0.51	1.20
Total # verbs	overlap	0.36	1.06
% of total verb stems that are AI	overlap	0.56	1.03
% of verbs that are TI (tokens)	overlap	0.73	0.47
% of total verb stems that are TI	overlap	0.65	0.40

TABLE 3. Comparing predementia and dementia samples using three analysis methods. Boldface indicates significance using the given analysis method.

We also include some additional supporting data, designed to respond to questions that arose based on analysis of the primary data. First, we took one predementia and one dementia text and examined the numbers of common tense and aspect prefixes. This was designed as a control, to verify that especially common elements were remaining frequent across all the data. Those results are in Table 4.

	PREDEMENTIA	DEMENTIA
TOTAL VERB TOKENS	652	519
<i>nih-</i> (past)	60	85
<i>he 'ih-</i> (narrative/dubitative past)	17	26
<i>nih 'ii-</i> (past imperfect)	33	37

TABLE 4. Comparison of the numbers of tokens of common elements in one predementia and one dementia sample text.

Second, we looked at the relationship between ‘dominant’ and ‘nondominant’ TA inflections in all five of the texts. Dominant pairs of inflections can be thought of as reflecting either the main characters in a narrative or the principal point of view in a narrative. In most Arapaho narratives, the dominant pair of inflections is *-oot* 3SG/4 and *-eit* 4/3SG—that is, there are two main characters in a given scene: one is proximate, one is obviative, and they act on each other. When a story happens to be told in first person, the dominant pair of inflections is *-eθen* 1SG/2SG and *-in* 2SG/1SG—that is, ‘you’ and ‘I’ are the key actors, or *-o’* 1SG/3SG and *-einoo* 3SG/1SG—‘s/he’ and ‘I’ are the key actors. This was intended to further evaluate the richness of relationships indexed by TA verb inflections. The results are in Table 5.

	PREDEMENTIA			DEMENTIA	
	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 1	SAMPLE 2
DOMINANT PAIR	62.90%	39.50%	55.60%	68.60%	73.30%
ALL NONDOMINANT	37.10%	60.50%	44.40%	31.40%	26.70%

TABLE 5. Comparison of dominant and nondominant TA inflections in predementia and dementia samples.

5. DISCUSSION.

5.1. EFFECTS OF DEMENTIA ON ARAPAHO MORPHOLOGY AND MORPHOSYNTAX: EVIDENCE FOR GRAMMATICAL LIMITATIONS. In this section, we consider specific grammatical features in Arapaho that appear to be affected by dementia. Since Arapaho verb stems in particular cannot occur without at least some basic prefixes and suffixes, we first ask how grammatical limitations are realized on Arapaho verbs.

PRESERVATION OF BASIC INFLECTIONAL PREFIXES, SUFFIXES, AND SUBORDINATION MARKING. Except for imperative forms, all Arapaho verbs obligatorily carry some marking of either tense or aspect. As Table 4 shows, these most common prefixes continue to be used heavily throughout dementia, even increasing somewhat. Phil is also able to continue alternating among at least the most common prefixes, rather than reducing usage to just a single one. However, the fact that he shows increasingly heavy reliance on the most common prefixes, relative to the total number of verb tokens, suggests that the richness and variety of tense/aspect marking is likely decreasing. This was not further investigated for this article.

As we have seen, Arapaho uses different stems for the transitive and intransitive forms of a verb (if it has both forms), and the intransitive forms take different person/number endings from the transitive forms. Phil’s speech does not show loss of basic person/number suffixes on intransitive verb stems. Since these suffixes are obligatory, this is not surprising. Furthermore, he shows the continued ability to switch between some of the appropriate intransitive suffixes, rather than settling on just a single one.

Another area where Phil shows at least partial preservation of premorbid abilities is in basic temporal subordination. Subordinate clauses require a verbal prefix of some kind indicating subordination. The prefix *tih-* is used for general temporal backgrounds, as in sentences such as the following.

- (27) *Tih-wooneihi-noo, nih'ii-neyeiθei-noo.*
 when-young-1SG PST.IMPF-go.to.school-1SG
 'When I was young, I went (regularly, habitually) to school.'

For the two sets of texts, the results from Table 1, broken out by prefix, are as follows.

- (28) *tih-* 'when' (general background)
 a. predementia (1980-era, three texts): 50/1483 verbs = 3.37% of verbs
 b. dementia (1989, 1993): 23/1251 verbs = 1.84% of verbs

The number of overall tokens makes statistical analysis problematic here, but clearly Phil preserves some ability to express relationships of subordination, though even with the simplest form of temporal subordination, the frequency of expression appears to be in decline.

PROBLEMS WITH TRANSITIVE (TWO-INFLECTION) VERBS. Based on the greater complexity of the Arapaho system for encoding transitive verbs with animate undergoers as compared to inanimate undergoers, we predicted that grammatical limitations would show up in the form of a greater decrease in the use of transitive verbs with animate undergoers. This appears to be the case: TA tokens decline from 24%, 26%, and 19% of the verbs, respectively, in the three 1980-era texts to 13% in 1989 and 6% in 1993. While this result is not statistically significant (probably due to the relatively small number of tokens, especially in the later texts), the numerical decline is suggestive (see Tables 1 and 2).

The number of discrete TA stems (i.e. different individual lexical items) did show a statistically significant decline. In addition, the number of different TA stems with multiple tokens (i.e. that were used more than once) declined from the predementia to the dementia texts. This is again not statistically significant, but is highly suggestive. The overall results closely match the hypotheses: fewer and fewer TA verbs were used, the range of lexical richness of the verbs declined, and when such verbs were used, there was an increasing reliance on a very narrow range of verbs for most of the tokens of use, to the point that in the final dementia text, only four of the twenty-four individual verbs were used more than once.

Finally, again supporting the hypothesis, more and more of the TA tokens that were used involved a restricted range of inflections. In Table 5 the three earlier narratives show higher percentages for the nondominant inflectional endings (of which there can be dozens), which probably means that Phil in his prime had brought more secondary participants into the narrative, rather than sticking narrowly with the most cognitively accessible main actors. This higher percentage of nondominant endings may also reflect more shifts from narration to dialogue (i.e. instead of 'he' and 'him' the teller switches into the personas of the characters and has them talk to each other as 'I' and 'you'). While the particular nature of the narrative may affect these figures, it appears that Phil relies more on a dominant pair of TA inflections as he goes further into dementia, suggesting that he increasingly focuses only on a narrow set of participants and/or a narrow set of points of view, and is decreasingly able to shift from descriptive narrative to character dialogue and back.

In contrast to the more constricted use of TA verbs in the later texts, there is no meaningful difference across the texts in Phil's use of TI, AI, or II primary verb forms, as can be seen by comparing the values for these categories in Tables 1 and 2 and the significance measures in Table 3. The number of tokens of each type, relative to the total verb tokens, remains relatively constant. The number of different individual stems of each type, relative to the total number of different individual verb stems, also remains rela-

tively constant, suggesting that there is not a major loss of lexical richness in these categories of verbs, unlike the TA verbs. Finally, the number of stems with multiple tokens remains relatively constant, suggesting that there is no clear shift toward a reliance on only a small subset of lexical items for most tokens of verb usage. These quite constant results across all three categories of verbs render the shifts in the TA verbs all the more interesting. Indeed, one finding they suggest in relation to lexical richness is that Phil is using fewer and fewer TA verb stems not because he cannot access the stems themselves as lexical items, but rather because he is simply avoiding TA stems due to the cognitive/inflectional burdens they produce.

When we compare Phil's results to those of his son (in Table 6), the preceding results are further confirmed. Note that measures of percentage of stems with multiple tokens are not included here, nor are separate measurements for II impersonal and II passive verbs, since the smaller size of the data for Phil's son prevents adequate comparison for these low-frequency measures.

DISCOURSE FEATURES	SAMPLE 1	SAMPLE 2	SAMPLE 3	MEAN	SD
Total # verbs	256.00	207.00	258.00	240.33	23.58
Total # verb stems	151.00	140.00	140.00	143.67	5.19
% of verbs that are TA (tokens)	36.72	19.32	18.99	25.01	8.28
% of total verb stems that are TA	27.81	18.57	18.57	21.65	4.36
% of verbs that are TI (tokens)	7.03	7.73	11.24	8.67	1.84
% of total verb stems that are TI	7.95	7.14	9.29	8.13	0.89
% of verbs that are either impersonal or passive (tokens)	0.78	1.45	3.57	1.93	1.19
% of verbs that are primary II (tokens)	11.33	20.29	13.18	14.93	3.86
% of total verb stems that are primary II	15.89	22.14	15.00	17.68	3.18
% of verbs that are AI (tokens)	44.53	51.21	53.10	49.61	3.68
% of total verb stems that are AI	47.02	50.71	53.57	50.43	2.68
% of total verbs with inflectional subordination	1.17	3.38	13.57	3.97	2.56
% of total verbs with prefixal subordination	2.35	6.28	1.94	3.52	1.96
Overall % of verbs with subordination (inflectional + prefixal)	3.47	9.66	9.30	7.48	2.84

TABLE 6. Comparative data from the speaker's son.

The means for his son's use of TA verbs fall within the standard deviations for Phil's predementia usage, which suggests that the two had similar linguistic abilities and tendencies. Conversely, Phil's later means fall not only well outside the standard deviation for his own earlier TA usage rates, but outside those of his son as well. For TI and II stems, his son's usage falls either within the standard deviation of Phil's predementia usage or just barely outside that deviation. This further reinforces the fact that Phil and his son were similar speakers, and thus makes Phil's drastic drop in TA usage relative to both his own predementia usage and that of his son all the more marked. Phil's son does show a higher rate of usage of AI stems in comparison to Phil, both predementia and during dementia, but the implications of this are unclear.

PROBLEMS WITH SUBORDINATION. Some of our strongest results concern subordination. While the results for the prefix *tih-* were already suggestive of a decline in this area, the overall pattern when all prefixes are examined is much clearer, as can again be seen by comparing the values for these categories in Tables 1 and 2 and the significance measures in Table 3. The number of verbs having prefixed subordination markers, relative to all verb tokens, declines from 12%, 10%, and 9% in the 1980-era texts to 7% and then 4% in the 1989 and 1993 texts. Smaller numbers of tokens make evaluation of suffixed and derivational subordination markers more problematic, but they likewise show

a shift from 5.9%, 5.0%, and 4.0% to 2.9% and 2.5% relative to the total number of verb tokens. When the two categories are combined, a strongly significant decline can be seen, from 18%, 15%, and 13% in 1980 to 10% and then 7% in 1989 and 1993. Subordination roughly declines by almost 50% in frequency.

When we look at the data for Phil's son in Table 6, we find that his usage of subordination generally is much lower than that of Phil's, predementia, with the difference mostly occurring in the prefixal subordination category. The reasons for this—slightly different narrative genres recorded? language shift? individual stylistic variation?—are unclear. While Phil's usage of subordination in dementia declines significantly relative to his own predementia usage, even in dementia it remains comparable to that of his son, who did not suffer dementia.

COMPENSATION MECHANISMS. The first compensation mechanism hypothesized was the increased use of impersonal verbs. Table 3 reveals a very significant increase in total number of II impersonal tokens relative to total verb tokens, as well as a major increase in such stems with multiple tokens, both of which indicate increasing usage. The second mechanism proposed for avoidance was passivization. When we look at II passive verbs, the results are even stronger than for the first mechanism. Overall tokens rise dramatically, as does the number of different individual lexical stems, as does the number of stems with multiple tokens. If we combine both avoidance mechanisms and look at the secondarily derived II forms, we find in fact that the tokens rise from roughly 2/7/5% to 10% and 13% of total verb tokens. The number of individual stems with multiple tokens rises from 20/23/19% of the overall II stems of these types to 42% and 45%. In contrast, as noted earlier, the number of basic, primary II stems and tokens remains largely unchanged across all of the texts, as do AI and TI stems and tokens. Thus what we find is that the significant decline in TA tokens and stems is complementary to the significant increase in secondarily derived II passive and impersonal forms.

When we examine Phil's son's usage of these two features in Table 6, we find that his usage falls within the standard deviation of Phil's predementia usage. Phil's usage in dementia shows a significant increase in relation to both his own earlier usage and that of his son. As in the case of the decline in TA verb usage, this increase in passive and impersonal usage is thus doubly marked.

DIFFERENCES, 1989–1993. Beyond the difference in mean values between the earlier and later data, there are also noticeable tendencies within the later data, from 1989 to 1993. In particular, a decline in TA verb usage, an increase in passive and impersonal stems, and a decline in subordination are all visible from 1989 (sample 1) to 1993 (sample 2). Thus all of the major changes from predementia to dementia become exacerbated as time goes on. While the data sizes do not allow meaningful statistical comparisons, these trends are certainly suggestive. (Note that the three earlier data samples are not time-ordered, and no trends across time are visible there.)

BEYOND COMPENSATION: UNGRAMMATICAL FAILURE TO PRODUCE VERBS. At this point, the reader might assume that Phil's language usage in dementia largely involves avoiding subordination, avoiding complex TA verbs, and replacing the latter with secondary II forms. But there is also a larger issue at play in his language usage—the fact that he has trouble producing verbs at all. In particular, there are many occasions in the dementia texts where Phil produces one, two, or even three preverbal prefixes, but never manages to actually produce a verb. In some cases there is termination of the pre-

fix(es) with a derivational detachment suffix *-ini* (Cowell & Moss 2008:231–32), as in the following.

- (29) cenihwooniini, nehe' Quannah Parker, Cochise hinee,
 cenih- wooni- ini nehe' Quannah Parker Cochise hinee
 IC.to.here- most.recent- DETACH this Quannah Parker Cochise that
 ʔebcebnooowuuhu' hiiʔe' ...
 ʔeb- ceb- noow- uuhu' hiiʔe' ...
 there- past/by/along- south- ADV over.there ...
 'More recently, this Quannah Parker, that Cochise, down along south there ...'

This suffix occurs in four situations in normal fluent speech. First, when the underlying verb is 'to be' (which is not expressed in Arapaho), the clause can terminate with prefixes plus *-ini*. Second, when the verb is very clear and easily recoverable (along with its inflections), it can be dropped and the detachment suffix used—in virtually all such cases, the verb has been explicitly used in the immediately preceding clause. Third, when a speaker wants to highlight the prefixes, or when unusual or especially long sequences of prefixes occur, the derivational detachment marker can be used to do so—detached prefixes are more salient than ones attached to the verb. But in these cases, the verb must follow immediately.

- (30) a. Attached prefixes
 Ne'-nih-'iis-iine'etii-ʔi'.
 that-PST-how-live(AI)-3PL
 'That's how they lived.'
 b. Detached prefixes
 Ne'-nih'iisi-ini hiine'etii-ʔi'.
 that-PST-how-DETACH live(AI)-3PL
 'THAT'S HOW they lived.'

In all of the cases above, the suffix can be understood as indicating emphasis on the prefix(es). Finally, the suffix can be used in situations of hesitation—but again, the verb should follow. What is notable about Phil's sentence in 29 is that the verb intended to follow the prefixes is unclear, and he never gets to a verb at all.

A more extreme version of the same situation occurs when Phil produces one or more prefixes (or sometimes part of a verb stem) and then simply stops midstream, as in the following sentence (where PS = a pause or break in a word).

- (31) niyou heet PS ...
 niyou heet- PS ...
 here.it.is where- PS ...
 'Here is where ...'
 [Next sentence: 'That {time} when it seems like everything was being written down, those feathers, here is that plume.']

This attempted sentence is completely ungrammatical. Of course, all speakers produce many mistakes in their speech that can be considered ungrammatical, but typically speakers self-correct. Here, no self-correction is forthcoming. Whereas Phil makes extensive use of the *-ini* suffix in his earlier narratives, both for markedness and as a hesitation device, in the later narratives he usually just uses the verbal prefixes and then stops completely. So it seems that the ability to use the detachment suffix as part of a hesitation process already involves a degree of grammatical processing that is difficult

for individuals affected by dementia: it would require them to both engage in secondary derivation on a prefix and look for a following lexical item at the same time, plus consider inflections.²

The two examples given above seem to suggest either anomia (difficulty in accessing lexical items) or problems with working memory as his key problems. We believe that an alternative explanation should be considered, however, for two reasons. First, Phil seems able to find most of the nouns, particles, and prefixes (especially lexical) that he is looking for. And second, we have seen no decline in lexical richness of usage for his AI, TI, and primary II verb forms (in terms of numbers of different verb stems)—the decline in lexical richness occurs only for TA verb forms. It seems unlikely that anomia would affect TA verb stems but not other classes of verb stems, nor nouns, particles, and prefixes. Thus we suggest that it is not primarily anomia that is producing verbless clauses, but rather an inability on Phil's part to insert the TA verbs into a complex matrix of prefixes and suffixes. This difficulty with insertion could in turn be due to a working-memory problem, but there is a further consideration. His problem in deploying verbs shows up with regard to all verb classes, in the form of verbless clauses. All of the statistical data in this article compare occurrences of different types of verbs and lead to the focus on TA vs. other verb types, but this comparison of course does not get at the issue of completely missing verbs.

If the missing-verb problem were due to anomia, a simple hypothesis would be that there would be far more ungrammatical instances of a pause/break (labeled as such in the database) in Phil's later texts. A quick comparison of one predementia text with a dementia text, however, reveals that the situation is not quite so simple. In fact, the predementia text has around sixty such occurrences, while the dementia text has around thirty. However, in the predementia text, over half of the occurrences are followed by self-corrections in which a completely grammatical utterance is produced, using the exact same prefixes and/or partial verb stem to complete the utterance, as in 32.

- (32) niine'eeno nii'eihiiho niihen PS
 niine'eeno nii'eihii- ho niihen- PS
 here.they.are eagle- OBV.PL oneself- PS
 niiheneheiθitou'u.
 niiheneheiθit- ou'u
 own.s.t.by.divine.blessing(TI)- 3PL
 'These eagles have power from the Creator.'

In the dementia text, however, self-correction occurs only twice among the thirty examples. Thus Phil's ability to self-correct and produce the desired utterance seems to have drastically declined over time.

This of course still leaves roughly thirty ungrammatical forms in both texts. Consider the following example from the 1980-era texts, however.

- (33) 'oh ne'nei'ooceinoot θeboowuuhu'.
 'oh ne'- nei'oocein- oot θeb- hoow- uuhu'
 but/and then- hold.on.tightly.to.rope(TA) 3SG/4 there- down- ADV
 'And then he held on tight to it, [lowering himself] on down there.'

² More generally, Arapaho is one of a relatively small number of languages where hesitation devices are necessarily linked to preceding elements in an utterance. The particle *nihii* meaning 'well ... uhh ...' can be used independently, but when used following a prefix, it is prosodically linked to the prefix by pitch accent, which is applied to the preceding syllable, so that *nih'ii-* (PST.IMPF) + *nihii* becomes *nih'itinihi* 's/he was uhh ...' (at least in the speech of the older fluent speakers). Thus, even signaling being confused takes grammatical effort.

Heetne' PS 'oh hinee heeθebi'to'owoot, nuh'uu[no]
 heet- ne'- PS 'oh hinee heeθeb- hi'- to'ow- oot nuh'uuno
 FUT- then- PS but/and that IC.there- INST- hit(TA) 3SG/4 this
 hitou.
 hit- ou
 3SG- blanket

'Then he will ... and he strikes this [eaglet] down there with his blanket
 [and covers it].'

In this case, Phil corrects from future tense to narrative/dramatic present, but otherwise maintains coherence, with the morpheme *θeb-* 'there' used both before and after the form that is cut short. Moreover, he produces an especially complex TA form following the pause/break, which has not just actor and undergoer but also instrument marked inflectionally on the verb. *Heetne' PS* is an ungrammatical utterance, and no material from the form is used in the subsequent completion of the clause (i.e. he does not say *heetne' PS*, *heetne'hi'to'owoot* or something similar), so in a narrow sense (in terms of the database labeling) this looks like the same thing as 29 above from the dementia narrative—an uncorrected/uncompleted ungrammatical utterance. But the two cases are actually quite different. The predementia example looks like a false start, abandoned and replaced by a fully grammatical and appropriate utterance. (Full analysis of this issue of verb nonoccurrence would require much additional labeling of the database and careful subjective analysis and judgments regarding pragmatic discourse coherence, which are beyond the scope of this article.)

To further illustrate why we argue that processing rather than anomia is the central issue, we cite one final example from the dementia narrative.

(34) bei'i'ei PS nonoote' nih'etnee'eeθ PS ...
 bei'i'ei- PS nonoote -' nih'et- nee'eeθ- PS ...
 paints.things/self.red(AI)- PS IC.fetch(AI) -3SG IRREAL- thus- PS ...

'Red ceremonial painting, he is fetching it, that's what he was supposed to ...'

[Next sentence: 'Here is where ...']

In this example, we find an AI verb initiated, but not finished or inflected, followed by another completed AI verb, followed by four prefixes (*nih'et-nee'eeθ-*) and then no verb. It seems fairly clear that what Phil was trying to say was something like 35.

(35) niis-bei'i'ei-θi', nih'et-nee'ees-noote'
 how-paint.self.red(AI)-3PL IRREAL-thus-fetch(AI)-3SG

'Their practice of ceremonial red painting, that's what he was supposed to fetch back [from Oklahoma].'

All of the lexical material for the latter sentence is present in the former one, but Phil seems incapable of putting it all together: he produces the verb with correct AI inflection, and the prefixes, but not the overall form. Since the verb typically follows a heavy load of prefixes in Arapaho, the result in Phil's speech is that the verb falls off the end of the utterance, so to speak, often resulting in nearly verbless discourse. It is difficult to see how the claim that this is a processing deficit would make a different prediction from the claim that this is a working-memory deficit. (In a typologically different language, such as a primarily suffixing language, different effects might be noted in relation to verb usage.)

Finally, we should note that the degree of language loss (particularly anomia) may be underestimated based on the recorded data. Recall that all of the material here represents traditional narratives that Phil likely told many times over the course of his life (the data-

base itself includes multiple versions of some of them). One would imagine that lexical retrieval (and forming linguistic structures as well) would be relatively easier for a speaker when producing such familiar narratives. Unfortunately, we do not have free conversations or novel narratives by Phil in Arapaho to compare with these stories.

5.2. CONCLUSIONS. The first and most obvious conclusion from the Arapaho data is that a speaker suffering from dementia who has grammatical limitations in English still uses some quite complex grammatical forms in Arapaho. The contrast between the extent of his limitations in Arapaho and in English is unlikely to be due to the fact that English was his second language. Phil was considered completely fluent in Arapaho English by his own family members; furthermore, prior to the onset of dementia, several hours of recordings show that Phil had been able to tell fifty-minute narratives in English without appearing to hesitate and search for words, and without switching to Arapaho at any point. Since he lived with non-Arapaho-speaking grandchildren for many of his later years, he spoke English daily, and indeed spoke as much or more English than Arapaho over the last twenty or so years of his life. Phil's preserved ability to use some complex Arapaho forms also cannot be entirely due to the tradition of formal oral narrative in Arapaho, which makes complex, ready-made discourse structures available to the speaker in a way not equivalent to English. So a victim of dementia whose first language is polysynthetic and agglutinating can maintain the ability to use verbal prefixes, suffixes, and simple subordination structures regularly, well into dementia.

The second conclusion, however, is that the more grammatically complex sets of Arapaho prefixes and suffixes, as well as more conceptually complex subordination, become increasingly difficult for this speaker. Note that in the case of the inflectional suffixes on verbs, it is not just the issue of two versus one suffix that causes difficulty, but the need to COORDINATE the two suffixes correctly with each other. Complex dynamics of proximate and obviative marking combine with a 2–1–3–4 person hierarchy and a series of direction-of-action themes, and all of this must be manipulated simultaneously in order to use transitive animate-undergoer verbs in Arapaho. Similarly, with subordination involving logical or consequential connection, two entire clauses must be conceptually linked and related properly to each other. It is this RELATIONAL ability, in connection with multiple actions, situations, or actors, and the grammatical structures used to express these relations in Arapaho, that seems to break down in this case of dementia, whereas Phil remains able to process and encode the temporality of a single event and to track single actors/subjects.

A third conclusion is that secondary derivational processes on verb stems, or at least the common, highly regular processes that create the impersonal and passive forms, are not grammatically difficult for Arapaho speakers, and that Phil uses these processes regularly in order to avoid the grammatical difficulties described in the preceding paragraph. It is likely that these common secondary verb forms are not really 'derived' by the speaker at all, but are simply retained as fixed lexical items, though laboratory testing of cognitive processing would need to be done to demonstrate this.

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