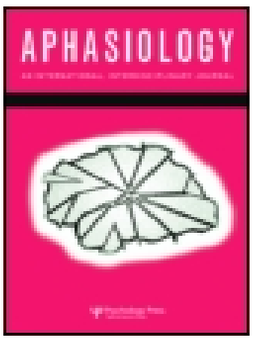

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Non-fluent aphasia in a polysynthetic language: five case studies

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ABSTRACT

Background: Polysynthetic languages can be roughly defined as languages which have an extreme morphological complexity. They present a range of challenges to linguistic and neurolinguistics theories that are based on standard average European languages. Yet, no studies exist on aphasia in such languages, and the communities that speak them have little or no access to assessment and language therapy.

Aims: The aim of this paper is to provide a first attempt at a characterisation of aphasia in a polysynthetic language, West Greenlandic.

Methods and procedures: We recorded semi-spontaneous speech from five participants with aphasia and compared their speech on several parameters with that of matched non-brain-damaged control participants. These parameters included standard production measures, measures of morphological complexity, and measures of syntactic complexity.

Outcomes and results: Our findings indicate that non-fluent aphasia in West Greenlandic is not associated with morphological impairment; instead, participants with aphasia produce shorter utterances, and there are trends indicating lower complexity across measures of syntax.

Conclusions: While somewhat surprising from the point of view of research on aphasia in standard average European languages, our findings align well with findings from other languages with complex morphology such as Finnish, Turkish, and Japanese. Our study highlights the need for a diverse range of crosslinguistic studies to inform linguistic and neurolinguistic theories.

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1. Introduction

Polysynthetic languages like West Greenlandic can be roughly defined as languages which have an extreme morphological complexity. They abound in affixes many of which have functions that are in other languages coded in lexical words such as verbs and adjectives, and they often include both verbs and arguments in the same single word. Speakers of polysynthetic languages thus often express in a single word what in other languages would

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be expressed by means of whole sentences, and they often make utterances consisting of one complex word only (Fortescue, Mithun, & Evans, 2011a).

Because of these features, polysynthetic languages challenge widely shared intuitions about how languages are built and work (Fortescue, Mithun & Evans 2011b). In particular, polysynthetic languages are central to understanding verbs and argument structure (Fortescue et al., 2011a, p. 2), the relationship between syntax and morphology (cp. Aronoff, 1993; Baker, 1996), and the distinction between lexical and grammatical items (are polysynthetic affixes grammatical morphemes?). These linguistic challenges entail that also our understanding of how language is processed and produced must potentially be refined – as well as our diagnosis of aphasia and our view of what happens when parts of language are lost as a result of brain damage. For instance, it is not obvious that the traditional assumption of a double dissociation between lexical items and grammatical items works for polysynthetic languages. In order to get an adequate idea of how language is built and works, and what happens when it is lost, it is thus crucial to collect aphasiological data from languages with a wide variety of architectures.

To our knowledge, no aphasiological studies of polysynthetic languages exist. None of the 39 languages mentioned in Beveridge and Bak's (2011) survey of languages explored in the years 2000–2009 are polysynthetic. Neither are any of the 40 languages for which Bastiaanse et al.'s (2016) multilingual Token Test is available, nor any of the languages in the aphasia anthology by Menn and Obler (1990) or big databases such as AphasiaBank. Personal correspondence with the contributors to the Oxford Handbook of Polysynthesis (2011a) confirms this picture.

It is high time for an aphasiological study of a polysynthetic language. First, because the communities that speak polysynthetic languages are characterised by absence of or severely limited access to assessment and language therapy. Second, because many polysynthetic languages are endangered.

In this paper, we aim at providing a first attempt at a characterization of aphasia in West Greenlandic. For that purpose, we explore a range of parameters that are widely accepted as important for characterizing aphasia. In addition to standard production measures such as speech rate, words per utterance, morphemes per utterance, and morphemes per word, we also explore sentence-level measures of valence, subordination, and transitivity, which may indicate possible syntactic problems. We also analyse the production of four broad classes of derivational affixes (nominal modifiers, verb modifiers, nominalisers, and verbalisers). These affixes may give an idea about both possible morphological problems and the relative affectedness of nominals and verbs. Moreover, the nominalisers and verbalisers represent a striking feature of WG morphology: the ability to switch from nominal base to verbal base and vice versa very liberally – sometimes several times within a single word.

We will use "external syntax" to refer to the syntax of West Greenlandic and "internal syntax" to refer to the morphology, following the literature (e.g., Fortescue, 1984a).

2. West Greenlandic grammar sketch

West Greenlandic Eskimo is a highly synthetic language. It is typologically remarkable as regards the sheer number and type of the affixes (bound morphemes) that can be inserted between lexical stems and inflectional endings – over 400 of these in more or

less productive use, some nominalising, some verbalising, some neutral, with numerous combinations frozen as units (see also Nielsen, 2019). There are also over 300 inflectional endings organised into nominal and verbal paradigms. For verbs these indicate mood and person/number of the subject (for transitive verbs also object), for nominals case, number and possessor. There is considerable fusion involved in these "portmanteau" endings with some unique endings encoding both person, number, and mood.

West Greenlandic words fall into three main classes: verbs, nominals (nouns, participles, pronouns and demonstratives), and uninflected particles. The latter category includes conjunctions, interjections and simple adverbials – there is also a handful of clitics. The first two categories consist of an obligatory stem followed by an inflection (zero in the case of absolutive case nominals), with the possibility of from none to at least eight or so derivational affixes between them, transparently ordered according to accumulating semantic scope away from the stem. The "neutral" affixes cover such meanings as aspect, degree, potentiality and manner. Notable are the many "heavy" verbalisers corresponding to full verbs in analytic languages. They cover such meanings as "be", "have", "think that", "want", and "acquire". West Greenlandic also possesses a number of valency-changing affixes, including causative and passive, but also antipassive (*-si-/-i-*, as in *inun-nik toqut-si-voq* "he killed people" as opposed to *inuit toqup-pai* "he killed the people"), and applicative (*-ut(i)-/-at(i)-*, as in *kama-ap-paa* "he is angry with him" as opposed to *kamap-poq* "he is angry"). There is a particular category of non-obligatory "sentential" affixes occurring just before the verbal inflection to indicate tense, modality, negation and "subjective colouration" (e.g., *-kulug-* "dear/bad"). Otherwise, derivational affixes do not occur in fixed "slots" and changing their order may result in a predictable change of meaning, according to scope. An inflected verb form may stand as a minimal sentence, reference to subject (and object) being contained in the inflection alone. The large number of productive affixes make up for the fact that WG, like all Eskimo languages, has a reduced stock of nominals and verbs, compared to European languages.

A characteristic trait of the language is the recursiveness of the morphology, whereby a verbal stem can be nominalised (or a nominal one verbalised), then again verbalised (or nominalised) by successive affixes up to several times within one complex word-sentence (or complex nominal). It must be capped off by a final inflection suitable for the whole as regards word class and transitivity (some affixes such as *-ler* "provide with" are inherently transitive and some such as *-qar* "have" are intransitive). There are also verb-extending and nominal-extending affixes that may occur together with the class-altering ones. As an example of a complex word-sentence consider the following, and note the accumulating scope of successive affixes:

1) *an-neru-ler-sin-neqar-sinnaa-sori-nngik-kaluar-pakka*

be.big-more-begin-cause-passive-can-think.that-not-however-IND.1.SG/3.PL[1]

"I don't think they can be made any bigger however."

Derivation by affixation fulfils many functions more commonly expressed by external syntax in less synthetic languages. External (sentential) syntax is on the other hand quite simple and rather free. A basic sentential order of SOXV (where X is an argument in an oblique case) can be varied for pragmatic purposes of topicalizing and focus, etc., but it

is not common (especially in the spoken language) to include all external arguments in a verbal sentence. There are also purely nominal sentences of the copular (equational and identifying) X = Y type. Within the noun phrase, modifiers (usually participials) must follow the head nominal but possessor nominals must precede it (possession is double marked, so also on the possessed nominal).

The language is ergatively organised, and the array of case endings on nominals includes an ergative ("relative") case (also functioning as genitive), plus a handful of spatial cases. The instrumental case is common in adverbial expressions and as the indefinite object of intransitive or derivationally de-transitivised verbs. Demonstrative stems (of which the language has a wide array) have somewhat different inflectional forms (also in adverbial usage). Verbal moods include interrogative and optative besides declarative (which has special negative forms), and (subordinate) causative, conditional and participial, and also "contemporative" with both subordinate and coordinate functions. Both nominal and verbal paradigms include a category "4th person", a (reflexive) third person referring to the subject of the verb.

A particular practical challenge with the study of polysynthetic languages has to do with the distinction between "frozen" constructions and productive morphology. What is to be considered a non-analysed lexical stem or bound affix is sometimes problematical, but often the correspondence of a complex but morphologically transparent sequence to a unitary lexical word or phrase in English gives a reliable clue, as does the overgeneralization of allomorphs (Fortescue, 1984a). It must be borne in mind however that productivity is not an either/or matter, but one of degree. Thus, for example, the combination of *-vik* ("place of Ving") and *-gi* ("agent has object as") is frozen as the construction *-figi* ("has as a place of Ving"). Similarly, the combination of *-tuq* (ACT.PTCP) and *-u* ("be N") is frozen as the construction *-tuu* which as a whole adds an aspectual meaning of duration to the conditional and some other moods (Fortescue, 1984a, p. 285). In principle, degree of productivity can be determined with a corpus linguistic method: For a given affix (or group of affixes) to be considered productively used, it must (roughly speaking) appear after more than one distinct stem which in turn has also been produced in combination with more than one affix. However, the current data set is too limited for reliable use of this strategy.

3. Methodology

3.1 General background information

Five individuals with aphasia (four female and one male; mean age: 69.8) and five non-brain-damaged control participants (four female and one male; mean age: 72.8) were recruited for the current study. The control participants were matched for gender, dialect, age, and education. The participants with aphasia were recruited with the aid of medical professionals from Queen Ingrid's Hospital in Nuuk and the nursing home Ippiarsuk in Nuuk. Control participants were recruited through Ippiarsuk and Nuuk senior social club. A background summary for all individuals with aphasia is presented in Table 1 and for all control participants in Table 2 below.

Certain limitations are present when testing participants in Greenland. First, no standardised diagnostic protocol is applied. The classification "expressive" and/or "impressive" aphasia is established by clinical consensus between non-specialist medical professionals and in collaboration with the families. We did not detect lexical

Table 1. General background information for aphasia patients (F = Female, M = Male, W = West, S = South, N = North, Ambi = Ambidextrous, R = Right).

Participant ID	A1	A2	A3	A4	A5
Gender	F	F	M	F	F
Age	62	69	68	66	84
Time post onset (TPO)	7 months	6 months	8 months	4 months + lacunar infarctions two days prior to the interview	5 years, 0 months
Occupation	Nursing home, social services	Laboratory assistant	Teacher, politician	Nursery teacher	Factory work, cleaning, sewing, knitting
Education level	Primary	Primary	Vocational	Vocational	Primary
Birthplace	Qaqortoq (S)	Maniitsoq (W)	Qeqertarssuaq (W)	Qullissat (W)	Qerrortusooq (W)
Languages	Monolingual	Late bilingual	Bilingual	Early bilingual, lost Danish after stroke	Monolingual
Handedness	R	Ambi	Ambi	R	R
Lesion type	Left medial-infarction (CT)	Left (on the basis of weak right side)	Left parietal infarction (CT)	Bilateral infarction. Basal ganglia. Largest in frontal left (CT)	Left subacute infarction, medial left large edema (CT)
Aphasia type	Expressive	No information	Expressive + anomia	Expressive	No information
Other cognitive issues	None	Memory (potential dementia)	None	Memory	None

Table 2. General background information for control participants (F = Female, M = Male, W = West, S = South, N = North, Ambi = Ambidextrous, R = Right).

Participant ID	C1	C2	C3	C4	C5
Gender	F	M	F	F	F
Age	69	66	72	64	93
Occupation	Kindergarten teacher	Nukissiorfiit	Caregiver (both young and elderly)	Nurse, interpreter	Housekeeper, babysitter, midwife's assistant, teacher's assistant, bank teller
Education level	Postgraduate	Vocational	Primary	Vocational	Primary
Birthplace	Qullissat (W)	Nuuk (W)	Qaqortoq (S)	Upernavik (N), moved to Paamiut (SW) when C4 was six years old	Nuuk (W)
Languages	Early bilingual	Late bilingual	Monolingual	Late bilingual	Late bilingual
Handedness	R	R	R	R	R

impairments, so we assume that all five participants with aphasia were non-fluent. No aphasia type was defined for A2 and A5 at the time of testing. Moreover, none of the patients had received specialised speech and language therapy as there are no trained professionals currently working in Greenland. Handedness was determined by self-report.

3.2 Data collection

Semi-spontaneous speech data, including picture description ("Cookie Theft"; Goodglass, Kaplan, & Baressi, 2001), picture narrative ("Broken Window"; MacWhinney, Fromm, Forbes, & Holland, 2011), and personal narrative, were collected via personal interviews with the exception of A1 and A5 who were interviewed via telephone because of time and transport constraints. The West Greenlandic interpreter informed all participants of the aims, methodology, and consequences of participating in the current study prior to them giving consent to being recorded. Ethical approval for the current study was granted from The Faculty of Humanities' Research Ethics Committee at the University of Copenhagen.

3.3 Data analyses

We transcribed and glossed all recorded data. Initial linguistic analyses were completed by the first author in cooperation with a native WG-speaking trained translator who also conducted the interviews. The interlinear glosses were checked by Michael Fortescue and Naja Trondhjem, both experts on WG and its aspects of theoretical linguistic interest. As outlined in the Introduction, we were interested in the relationship between internal and external syntax. Aside from conventional aphasiological production measures, we therefore examined internal syntax in the form of derivational affixes, including type and token counts. To explore the external syntax, we counted argument and agreement errors and compared the production rate of subordinate and transitive clauses as well as valence-changed verbs. We counted everything with final verbal inflection as a verb and everything with final nominal inflection as a nominal. Participles constituted a particular challenge as participial inflection can both function as a subordinate mood and as a nominaliser. We decided to count word-internal participial morphemes as nominalisers and word-final participial inflections as subordinate mood, based on classifications in Fortescue (1984a). Another challenge lay in deciding which constructions were lexicalised (or "frozen"). We used the presence versus absence of entries in online dictionaries (Ilinniusiorfik, 2010; Oqaasileriffik, 2018) as classification criteria: If a combination of morphemes was present as a distinct entry, we classified this combination as frozen. This was for example the case for *siullerpaamik* ("first of all") and *qaqutigut* ("rarely"). As for the utterance boundaries, these were decided by the first author in collaboration with the WG interpreter. Long pauses, full stops after syntactically complete sentences, and interruptions by the interpreter counted as utterance boundaries. Utterance length was determined by number of morphemes as well as number of words. We aimed at collecting 300 productive morphemes per task as previous aphasiological literature has shown 300 words are enough to serve as a reliable measure of a patient's speech (Prins & Bastiaanse, 2004). Our measure of speech rate included pauses, false starts, repetitions, and self-correction.

Given the fact that none of the participants in fact reach 300 morphemes per tasks, we have pooled the figures for each of the areas of interest (descriptive statistics can be found in Appendix A). Given the variation across participants and the limitations of the available background information, we statistically compared each patient individually to the control group on all our variables using the modified t-test method developed by Crawford and Howell (1998) including Holm-Bonferroni corrections for multiple comparisons.

4. Analyses of speech samples

4.1. Production parameters

All five participants produced significantly fewer words per utterance than the control group (A1: $t(5) = -2.81$, $p = 0.024$; A2: $t(5) = -4.14$, $p = 0.007$; A3: $t(5) = -2.29$. $p = 0.042$; A4: $t(5) = -4.01$, $p = 0.008$; A5: $t(5) = -3.62$. $p = 0.011$) but did not otherwise differ significantly with regard to speech rate, morphemes per word, or morphemes per utterance (see Table A1 in Appendix A for descriptive statistics and Table A2 in Appendix A for statistical tests).

4.2. Verbal modifiers, nominal modifiers, nominalisers, and verbalisers

Verbal modifiers include epistemic, modal, and aspectual affixes as well as subjective colouration affixes. Nominal modifiers include diminutives, augmentatives, and elements that would be expressed within a noun phrase as adjectives or adverbs in English.

None of the participants with aphasia appeared to differ significantly from the control group with regard to production of nominal modifiers, verbal modifiers, nominalisers, or verbalisers (see Tables B1–B4 in Appendix B for descriptive statistics and statistical results). Regardless of whether types and tokens were counted per task or across all tasks, participants with aphasia did not show lower variation than controls. Due to the lack of significant differences, we will not discuss the case-by-case results further.

Words which included several nominalisers and verbalisers were rare in the corpus. The group of individuals with aphasia only produced one instance (corresponding to 0.28% of all words) while the control group produced six instances (corresponding to 1.05% of all words).

4.3. External syntax

To explore external syntax, we examined subordination, valence-change, and transitivity. Refer to Table 1 for descriptive statistics and Table 2 for case-control statistics. None of the participants with aphasia differed significantly from the control group on these three parameters. However, it is worth noting that for all the participants with aphasia, the proportion of subordinate verbs (except for A5), proportion of verbs that included a valence-change (antipassive, passive, causative, and applicative), and proportion of transitive verbs (except for A3) were below the average produced by the control group (see Table 1).

4.4. Errors and omissions

Close analyses of the entire corpus revealed that neither participants with aphasia nor control participants made a significant amount of errors with regard to the inflectional affixes. The participants with aphasia made a total of eight errors. Of these eight, two

Table 1. Proportion of subordinate verbs, proportion of verbs that include a valence-change (antipassive, passive, causative, and applicative), and proportion of transitive verbs across tasks, including group means and standard deviations (SDs).

	% subordinate verbs	% valence-changed verbs	% transitive verbs
A1	35.29	0.00	5.88
A2	30.00	6.67	10.00
A3	38.64	5.68	29.55
A4	23.08	10.26	10.26
A5	50.00	11.54	15.38
Mean	**35.40**	**6.83**	**14.21**
SD	**10.06**	**4.53**	**9.21**
C1	42.19	23.44	12.50
C2	38.24	17.65	44.12
C3	46.51	18.60	20.93
C4	33.33	9.52	38.10
C5	50.00	13.64	18.18
Mean	**42.05**	**16.57**	**26.76**
SD	**6.59**	**5.26**	**13.61**

Table 2. Holm-Bonferroni-corrected modified case-control t-test results for the difference between proportions of subordinate verbs, valence-changed verbs (antipassive, passive, causative, and applicative), and transitive verbs. All p-values are one-tailed.

	Subordinate mood verbs	Valence-changed verbs	Transitive verbs
A1	$t(5) = -0.94$, $p = 0.201$	$t(5) = -2.88$, $p = 0.023$	$t(5) = -1.40$, $p = 0.117$
A2	$t(5) = -1.67$, $p = 0.085$	$t(5) = -1.72$, $p = 0.080$	$t(5) = -1.12$, $p = 0.162$
A3	$t(5) = -0.47$, $p = 0.331$	$t(5) = -1.89$, $p = 0.066$	$t(5) = 0.19$, $p = 0.430$
A4	$t(5) = -2.63$, $p = 0.029$	$t(5) = -1.10$, $p = 0.167$	$t(5) = -1.11$, $p = 0.165$
A5	$t(5) = 1.10$, $p = 0.166$	$t(5) = -0.87$, $p = 0.216$	$t(5) = -0.76$, $p = 0.244$

concerned a missing habitual aspect marker (see (1) below), two concerned transitive inflectional endings (2), two concerned argument-verb agreement (3), one was incorrect mood, and one was a lexical selection error. Aside from the lexical selection error, all these errors seemed to occur in the relationship between verbs and their dependents, especially when the relationship was not straightforward.

Data from participant A1 provide an example of an omission of an obligatory habitual aspect maker in (1). Both verbs should have a habitual aspect in coordinated clauses like these. Thus, the second verb, *ajerpoq*, should have been *ajertarpoq*.

(1) *ilaanni* *iluarsisarpoq* *ilaanni* *ajerpoq*
ilaanni iluar −si −sar −poq ilaanni ajer −poq
sometimes is good become HAB.IND IND.3.SG sometimes be bad IND.3.SG
"Sometimes it becomes good, sometimes it is bad."

Data from participant A2 provide an example of an incorrect transitive inflectional ending. After we asked participant A2 to speak WG instead of Danish, she asked:

(2) *paasiuminaatsilaarpatilluunniit*

paasi	−uminaat	−si	−laar	−pati	= lluunniit
understand	is difficultto	become	a little	COND.3.SG/2.SG	= or

"Even though she can't understand you?"

The transitive inflection on this verb should have been *-panga* with 3.SG subject and 1.SG object ("she can't understand me") instead of *-patit* with 3.SG subject and 2.SG object ("she can't understand you").

Data from participant A5 provide an example of an inflectional error regarding complex argument-verb agreement. In (3) below, the static verb required locative case instead of terminalis case:

(3) *taqqavaniinnerpunga* *Sanamut*

taqqava	−niin	−ner	−punga	Sana	−mut
there(south)	be in location	I wonder	IND.1.SG	Sana	TRM

"I was probably down south. To Sana."

While *Sanamut* in (3) is in the terminalis case and agrees with the demonstrative pronoun base of the verb *taqqavaniinnerpunga*, the static nature of the whole main verb requires *Sana* to be in locative case – *Sanami* – and thus function as an adverbial phrase. An example of an error on transitive inflectional ending.

5. Discussion

The current paper presents the first study of aphasia in a polysynthetic language. We compared data from five individuals with aphasia to data from five matched control participants with a particular focus on derivational morphology and external syntax. Because of the lack of precise diagnoses, we compared each individual with aphasia to the control group on several parameters: morphemes per utterance, morphemes per word, morphemes per second, and proportion of nominal modifiers, verbal modifiers, nominalisers, verbalisers, subordinate mood verbs, transitive verbs, and valence-changed verbs. The main difference found was that individuals with aphasia produced fewer words per utterance. Perhaps surprisingly, they did not make more inflectional morphology errors than the control participants and also did not produce fewer morphemes per word. There were no differences in either the production or token/type ratios of any of the four classes of derivational affixes. As for external syntax, there were also no significant differences although the descriptive statistics indicate a trend towards lower complexity across valence, transitivity, and subordination overall. Given the lack of significant differences in areas where we would perhaps expect such, it is relevant to assess whether our findings are consistent with existing literature on aphasia and West Greenlandic. The results of this pilot study further highlight the need for investigation of this language group.

In light of the morphological complexity of polysynthetic languages, it may seem surprising that aphasia in none of the five patients is associated with an impairment of the morphology. Below, we first discuss these findings in light of aphasiological research on

the agglutinating languages Finnish, Japanese, and Turkish since agglutinating languages are the closest relatives to polysynthetic ones that have been studied. Subsequently, we discuss our results in light of research assessing how children acquire West Greenlandic in order to illuminate which areas of WG grammar are most difficult and which carry the heaviest communicative burden. We will then assess whether aphasiological research on verbs and their dependents can provide tentative explanations for the findings in the current study. Finally, we provide an account of our findings which takes into consideration both research on agglutninating languages and acquisition research on WG.

5.1 Aphasia in agglutinating languages

We base our comparison with studies of agglutinating languages on the chapters on Finnish and Japanese found in Menn and Obler (1990) and on Slobin's (1991) study of Turkish. Niemi, Laine, Hänninen, and Koivuselkä-Sallinen (1990) provides evidence from two agrammatic case studies with two age- and education-matched control participants. Analyses of morpheme errors and omissions show a similar pattern to the one found in the current study with very few ungrammatical substitutions and even fewer omissions. The authors refrain from analysing derivational relations of Finnish verbs, citing the same difficulties that we have encountered regarding the continuum of "frozen" and productive constructions: "Since the derivational relations of Finnish verbs are often opaque and since there exists a continuum of opacity-transparency in the derivations (Niemi, Koivuselkä-Sallinen, & Laine, 1987; Räisänen, 1978), no totals are given for omissions and substitutions for the affixes." (Niemi, Laine, Hänninen, & Koivuselkä-Sallinen, 1990, p. 1020). Production rates and syntactic string complexity in the Finnish case studies are comparable to the ones found in the current study. Like our individuals with aphasia, Niemi et al.'s participants on average spoke at about half the pace as controls and produced "syntactic strings" that were about half as long (recall though that the differences we found were not significant). The individuals with aphasia did not delete affixes in speech – instead, the main deviations were simplicity and shortness of syntactic patterns (phrases and sentences). A similar pattern was found in Sasanuma, Kamio, and Kubota's (1990) study on Japanese aphasia. Here, predicate inflectional forms were preserved almost perfectly. The two individuals with aphasia in this study retained the ability to assign grammatical roles as well as construct complex predicates, noun phrases, and complex clauses, although they tended to produce simpler or incomplete structures.

Turkish is the most widely studied language within this group, still the number of studies is scarce and mostly based on the results of structured tasks (Arslan, Bamyaci, & Bastiaanse, 2016). At the sentence level, Turkish speakers with aphasia were found to have problems with the production and comprehension of complex sentences, including relatives and interrogatives (Arslan, Gür, & Felser, 2017; Aydin, 2007; Yarbay Duman, Aygen & Bastiaanse, 2008; Yarbay Duman, Aygen, Özgirgin, & Bastiaanse, 2007), but "telegraphic speech" was not detected (Slobin, 1991). In a study of 7 individuals with Broca's aphasia and 10 individuals with Wernicke's aphasia native speakers of Turkish, Slobin (1991) found, similar to the findings from Finnish and Japanese, that individuals with aphasia used both nominal and verb affixation appropriately. The 7 individuals with Broca's aphasia used a limited set of verb forms in a contextually appropriate fashion while the 10 individuals with Wernicke's aphasia produced a wide range of forms – some of which were semantically anomalous but all of

which were morphosyntactically correct. All individuals with aphasia studied by Slobin (1991) produced verbs which were inflected for person, number, modality, negation, tense, and aspect. Bare stems were not produced, and neither were bare infinitives were produced.

Recent studies with Turkish speakers with agrammatism have shown that tense morphology and evidentiality are susceptible to impairment. Problems with past tense morphology have been documented by Bastiaanse et al. (2011) and Yarbay-Duman and Bastiaanse (2009), whereas Arslan, Aksu-Koç, Maviş, and Bastiaanse (2014) found that direct evidentials are more severely affected than indirect evidentials. However, this does not challenge the generalization that in synthetic languages (the agglutinating languages Finnish, Japanese and Turkish and the polysynthetic language West Greenlandic) individuals with non-fluent aphasia do not seem to have morphological problems to the degree consistently found in more analytic languages such as English. Still, our findings, as well as the findings from Finnish, Japanese, and Turkish, are consonant with the crosslinguistic definition of agrammatism given in Menn and Obler (1990): "For cross-language studies, the definition of agrammatism must be framed in a fashion which is independent of the morphological and syntactic devices that any particular language may use. As a working basis, we take the features of slow rate and short sentence and phrase length as definitional; we also look for some 'limited use' of syntactic and morphological devices" (p. 3).

In Sections 5.3 and 5.4 below, we discuss possible explanations of the differences between non-fluent aphasia in synthetic and analytic languages.

5.2 Language acquisition in West Greenlandic

Studies of how children acquire WG grammar are quite few in number. An early example is Fortescue (1984b), a case study of one child at the age of 2;3. This child, Aqissiaq, appeared already to have successfully acquired around 24 derivational affixes and around 40 inflectional endings at an age where children with more analytic languages like English are only just learning their first inflections (Brown, 1973, p. 12). He had also mastered the morphophonemic patterns for attaching these affixes to different stem types and other affixes. Aqissiaq had acquired at least one token of every type of derivational affix (see the WG grammar sketch above) and used them by and large in the right order as determined by semantic scope. The only essential aspects of WG grammar that Aqissiaq had not yet acquired at the time of testing were recursive morphology – the ability to switch back and forth between verbal stems and nominal stems within one word – and complex clause constructions (the latter perhaps unsurprising as Aqissiaq had not reached a stage where he produced enough words per utterance for complex clauses).

In a later quasi-longitudinal study of the acquisition of West Greenlandic by five children aged 2;2 to 5;2 (Fortescue & Olsen, 1992), certain unusual traits became apparent which have some bearing on the aphasia data presented here. Most significantly, none of the children ever produced uninflected nominals or verbs, however simple or complex the words were internally (also the case in our aphasia data, disregarding restarts). The earliest forms acquired by the children were clearly lexicalised combinations of stem plus inflection – only later, as more stems and inflections were acquired, could productivity of the morphemes concerned be demonstrated. The general process of development was one of expansion "from within", i.e., by inserting a derivational affix commonly heard in the input between a known stem and a known inflection, then as familiarity with the affix grew, inserting a second or third one

before or after it, and so forth. Amongst the earliest acquired affixes were the "sentential" ones always occurring just before inflections. Nominalisers, verbalisers, and productive recursion, on the other hand, were acquired relatively late (second child at 3;1 had only acquired *-u-* "be N"). Subordinate clauses were also acquired late – at age 3;1, the second child produced only one complex utterance displaying subordination.

These findings appear to mirror the deterioration found in the current study. Firstly, in both young children and individuals with non-fluent aphasia, morphology (or internal syntax) is surprisingly complex: inflectional and derivational morphology are acquired early and lost late (if ever) in WG. Secondly, in both young children and individuals with non-fluent aphasia, (external) syntax is simple: Both complex clauses and recursive morphology were also significantly impaired for at least some of our individuals with aphasia, parallel to the children's acquisition patterns. Four out of five individuals with aphasia did not produce a single productive instance of multiple nominalisers and verbalisers within one word, and the last patient only produced one instance. The fact that all five individuals with aphasia produced significantly fewer words per utterance than the control group indicates that complex clauses present a challenge for them.

5.3 Does West Greenlandic support a verb-based account of aphasia?

One influential trend in aphasiological research concerns the idea that many of the problems with grammatical morphemes observed in non-fluent aphasia are closely related to deficits associated to verbs and verb retrieval (Miceli, Silveri, Villa, & Caramazza, 1984; Saffran, Berndt, & Schwartz, 1989; Zingeser & Berndt, 1990; Thompson, Shapiro, Li, & Schendel, 1995; Bastiaanse & Jonkers, 1998; Bastiaanse & Edwards, 2004; Bastiaanse & van Zonneveld, 2004; Lee & Thompson, 2004; to name just a few). Patients with aphasia, especially those with non-fluent aphasia, have been found to produce fewer verbs or display lower type/token ratios (e.g., Bastiaanse & Jonkers, 1998; Caramazza & Hillis, 1991). The hypothesis is that verbs are problematic due to the inflectional markers that they host, e.g., tense and agreement markers (Burchert, Swoboda-Moll, & De Bleser, 2005; Faroqi-Shah & Thompson, 2007; Friedmann & Grodzinsky, 1997; Wenzlaff & Clahsen, 2004), or due to the complexity of their argument structure (Bastiaanse & van Zonneveld, 2005; Thompson, 2003).

A verb-based theory is partly supported by the current study. On the one hand, our individuals with aphasia did not produce fewer verbs than the control group. On the other hand, all but one of the errors in the current study occurred with the relationship between verbs and their dependents. However, this was also the case for the control group, so this is potentially just a relatively difficult area of the grammar. Moreover, as none of the individuals with aphasia produced an amount of errors significantly different from zero, we cannot use this finding as definite support. Further evidence from highly synthetic languages is needed.

5.4 An account of non-fluent aphasia in WG

In order to understand the patterns we observed for non-fluent aphasia in West Greenlandic, it is worthwhile looking at attempts to account for the similar patterns found in agglutinating languages (cf. Section 5.1). In their study of Finnish, Niemi et al. (1990) suggest that their

informants had problems with syntax, but not with morphology, as what mostly happened to affixes in their data was that they were replaced by less marked ones. This suggestion seems to be in line with the more general observation that individuals with non-fluent aphasia do not produce bare stems or roots if these cannot function as words on their own (e.g., Grodzinsky, 1990). If this observation is correct, it makes possible a straightforward account of the fact that *inflectional* morphology is both among the first things to be acquired in WG language acquisition (cf. Section 5.2) and among the last things to disappear in WG non-fluent aphasia: Unlike what is the case in English, WG noun and verb roots are bound, and cannot function as words on their own (the only exception is nouns in the absoultive singular). Moreover, there are no uninflected word forms (such as English infinitives) with which inflected words can be substituted. If you produce words in WG, then, inevitably you must produce inflectional affixes as well (unless you produce an absolutive singular noun).

This same account does not work for *derivational* affixes in WG non-fluent aphasia, however. Like inflectional affixes, as discussed, derivational affixes are acquired early by children and retained in non-fluent aphasia. However, unlike inflectional affixes, derivational ones are not required in order for a linguistic string to be a word. The key to understanding this difference is the nature of WG derivational affixes. As discussed in Section 2, some of these affixes translate into full verbs or adverbs in analytic languages like English. In other words, they may be rather important for communicative purposes.

Slobin (1991) interprets the retaining of Turkish verb affixes as motivated by the reliability of these high information value cues to grammatical relations in Turkish, which makes them resilient in cases of aphasia (consistent with the competition model; MacWhinney, 1987). In line with this, recent studies have argued that non-fluent aphasia can to some extent be seen as the result of an adaptive response to processing difficulties in which the production of elements that are important for communicative purposes – i.e., elements that represent foreground information – are given top priority at the cost of less crucial elements that represent background information (Boye, Bastiaanse, Harder, & Martínzez-Ferreiro, sbm; Ishkhanyan et al. 2017; Nielsen, Boye, Bastiaanse & Michel Lang, 2019). This suggests that WG derivational affixes are retained because they represent crucial information.

A usage-based theory of grammatical status (Boye & Harder, 2012) defines grammatical items as items that are by convention associated with background information, hence entrenched as background elements. Based on this theory, one might hypothesize that some WG derivational affixes are in fact incorporated lexical items rather than grammatical morphemes.

To sum up the discussion thus far, the remarkable fact that non-fluent speech differs only little grammatically from speech of healthy individuals in WG may be seen as a result of the interplays between general features of non-fluent speech and peculiarities of polysynthetic languages. First, non-fluent speech consists of words and does not contain bare stems or roots. In WG, this entails that inflectional affixes are produced, because such affixes are obligatory in WG words (with the exception of absolutive singular nouns, as mentioned above). Second, non-fluent speech retains foreground items. In WG, this entails that derivational affixes are produced because they have the potential to express foreground information and are important for communicative purposes.

A third peculiarity is that WG sentences and utterances often consist of one word only, a "word-sentence" (see Sections 1 and 2). This means that the interplays that result in a rather

intact morphology (or internal syntax) also result in a rather intact syntax. In this respect, we would expect that polysynthetic languages like WG differ from agglutinating ones like Finnish, Japanese and Turkish, which do not show incorporation to a comparable extent.[2]

There is reason to expect that the preservation of morphology (and syntax) comes with a cost. Studies of Dutch (Bastiaanse & Jonkers, 1998) and of English and Swahili (Abuom & Bastiaanse, 2012) found a trade-off between verb diversity and verb inflection such that speakers who get the inflections right tend to have little verb variation, whereas speakers who preserve verb variation tend to have problems with inflections. The present study found support for such a trade-off only in two respects: 1) the fact that all or most of the individuals with aphasia had (non-significantly) lower proportions of subordinate verbs, verbs that included a valence-change, and transitive verbs than the proportions found in the speech produced by the control group; and 2) the fact that individuals with aphasia produced fewer words per utterance.

6. Conclusion

The results from the current study indicate that West Greenlandic speakers with aphasia do not have impaired morphology compared with control participants. None of the individuals with aphasia make either errors or omissions at a higher rate than controls.

These results can be accounted for as a consequence of interplays between general features of non-fluent speech in aphasia and peculiarities of polysynthetic languages. 1) WG speakers with non-fluent aphasia retain inflectional affixes because WG nouns and verbs require inflections and because, like other speakers with non-fluent aphasia, they produce existing words. 2) WG speakers retain some derivational affixes because some WG derivational affixes have the potential to be foreground information, and because non-fluent speech generally retains foreground elements. 3) WG speakers with non-fluent aphasia seem to have little problems with syntax because it is perfectly normal in polysynthetic languages that sentences and utterances consist of one word only (a "sentence-word").

The main difference between individuals with aphasia and healthy controls lies in utterance length with individuals with aphasia producing fewer words per utterance. There also appear to be some trends in the external syntax with at least some participants with aphasia producing fewer subordinate mood verbs, fewer transitive verbs, and fewer valence-changed verbs. These differences may reflect the cost paid for a virtually intact morphology.

Notes

1. Abbreviations for grammatical terms used in this paper: ACT = active; 1 = 1st person; 2 = 2nd person 3 = 3rd person; IND = indicative; COND = conditional; HAB = habitual aspect; TRM = terminalis case; ANA = anaphoric; N = noun; O = object; PL = plural; PTCP = participle; S = subject; SG = singular; V = verb.
2. WG does not display incorporation in the usual sense of noun incorporation. Its 'quasi-incorporation' is produced by lexically heavy verbal affixes ('have', 'get', 'say', etc.) attaching to any suitable noun base. Finnish and Japanese do not have either typical incorporation or incorporation of affixal "quasi-incorporation" to the same extent. Turkish does have some limited "quasi-incorporation" (a few verbalizers like "have" and "be"), but the Turkish verbalizers are much fewer and not as lexically heavy as the many dozens of verbalizers in WG.

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Appendix A

Table A1. Production parameters across the three tasks with group means and standard deviations.

	Words/utterance	Morphemes/utterance	Morphemes/second	Morphemes/word
A1	2.78	4.22	0.95	1.52
A2	1.80	3.97	0.81	2.20
A3	3.16	5.87	1.02	1.86
A4	1.90	3.97	0.82	2.04
A5	2.18	4.11	0.67	1.89
Mean	**2.37**	**4.43**	**0.85**	**1.90**
SD	**0.59**	**0.81**	**0.14**	**0.25**
C1	4.91	11.32	1.87	2.29
C2	5.01	9.59	1.57	1.95
C3	4.38	10.36	1.47	2.34
C4	5.82	12.41	1.89	2.14
C5	4.08	6.94	1.19	1.72
Mean	**4.84**	**10.12**	**1.60**	**2.09**
SD	**0.67**	**2.07**	**0.29**	**0.26**

Table A2. Holm-Bonferroni-corrected modified case-controls t-test results for differences on the four production parameters. All p-values are one-tailed. Significant results are marked with an asterisk.

	Words/utterance	Morphemes/utterance	Morphemes/second	Morphemes/word
A1	$t(5) = -2.81$, $p = 0.024$*	$t(5) = -2.60$, $p = 0.030$	$t(5) = -2.05$, $p = 0.055$	$t(5) = -2.00$, $p = 0.058$
A2	$t(5) = -4.14$, $p = 0.007$*	$t(5) = -2.71$, $p = 0.027$	$t(5) = -2.49$, $p = 0.034$	$t(5) = 0.39$, $p = 0.360$
A3	$t(5) = -2.29$, $p = 0.042$*	$t(5) = -1.87$, $p = 0.067$	$t(5) = -1.83$, $p = 0.071$	$t(5) = -0.81$, $p = 0.232$
A4	$t(5) = -4.01$, $p = 0.008$*	$t(5) = -2.71$, $p = 0.027$	$t(5) = -2.46$, $p = 0.035$	$t(5) = 0.18$, $p = 0.435$
A5	$t(5) = -3.62$, $p = 0.011$*	$t(5) = -2.65$, $p = 0.028$	$t(5) = -2.93$, $p = 0.021$	$t(5) = -0.70$, $p = 0.261$

Appendix B

Table B1. Pooled proportions of verbal and nominal modifiers across tasks, including group means and standard deviations (SDs).

	% nominal modifiers of morphemes	% verbal modifiers of morphemes
A1	1.32	5.26
A2	0.00	9.56
A3	0.49	9.56
A4	0.51	13.33
A5	0.87	16.52
Mean	**0.64**	**10.85**
SD	**0.49**	**4.27**
C1	2.64	10.82
C2	1.53	8.67
C3	0.41	18.70
C4	0.80	13.20
C5	0.00	4.55
Mean	**1.08**	**11.19**
SD	**1.04**	**5.27**

Table B2. Holm-Bonferroni-corrected modified case-controls t-test results for the difference between proportions of nominal and verbal modifiers. All p-values are one-tailed.

	Nominal modifiers	Verbal modifiers
A1	$t(5) = 0.25$, $p = 0.409$	$t(5) = -1.03$, $p = 0.181$
A2	$t(5) = -0.95$, $p = 0.198$	$t(5) = -0.28$, $p = 0.396$
A3	$t(5) = -0.52$, $p = 0.316$	$t(5) = -0.28$, $p = 0.396$
A4	$t(5) = -0.50$, $p = 0.322$	$t(5) = 0.37$, $p = 0.365$
A5	$t(5) = -0.18$, $p = 0.431$	$t(5) = 0.92$, $p = 0.204$

Table B3. Pooled proportions of verbalisers and nominalisers across tasks, including group means and standard deviations (SDs).

	% nominalisers of morphemes	% verbalisers of morphemes
A1	1.32	0.00
A2	1.47	2.94
A3	0.49	2.70
A4	2.56	2.56
A5	1.74	4.35
Mean	**1.52**	**2.51**
SD	**0.75**	**1.57**
C1	2.64	3.13
C2	2.55	3.06
C3	4.07	6.50
C4	2.00	2.40
C5	1.52	1.52
Mean	**2.56**	**3.32**
SD	**0.96**	**1.89**

Table B4. Holm-Bonferroni-corrected modified case-control t-test results for the difference between proportions of nominalisers and verbalisers. All p-values are one-tailed.

	Nominalisers	Verbalisers
A1	$t(5) = -1.18$, $p = 0.152$	$t(5) = -1.60$, $p = 0.092$
A2	$t(5) = -1.04$, $p = 0.179$	$t(5) = -0.18$, $p = 0.432$
A3	$t(5) = -1.97$, $p = 0.060$	$t(5) = -0.30$, $p = 0.390$
A4	$t(5) = 0.00$, $p = 0.500$	$t(5) = -0.37$, $p = 0.366$
A5	$t(5) = -0.78$, $p = 0.240$	$t(5) = 0.50$, $p = 0.322$