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A socially anchored approach to spatial language in Kalaallisut

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Abstract: In this article we demonstrate the fundamental relationship between the linguistic encoding of spatial relations and the topography of Greenland as an island, more specifically as a large island with considerable inland ice, and social engagement with that space. Kalaallisut (or Greenlandic, ISO 639-3 kal) uses an absolute frame of reference and a cardinal direction system that arises from an environmentally anchored coastal orientation system. Sociocultural knowledge and experiences play an important role in this system. It is deeply rooted in the geophysical environment, and changes to that environment can and do affect the linguistic encoding of space. Crucially, changes in people's relationship with the environment affect how it is conceptualized in language. This is part of a broader pattern of Inuit language usage in changing Arctic environments and societies.

Keywords: Arctic; deixis; Inuit; sociotopography; space

1 Introduction

Kalaallisut (ISO 639-3 kal) is an Unangan-Yupik-Inuit language spoken by approximately 50,000 people in Greenland and Denmark, primarily on Greenland's west coast. It is the official, standardized language of Greenland, based on dialects spoken in the Sisimiut/Nuuk/Maniitsoq area. It is highly polysynthetic (suffixing), and exhibits a rich grammatical and lexical system for the encoding of spatial relations. The research we present here applies specifically to language usage on the west coast of Greenland. As shown in Section 3, the Kalaallisut spatial system is highly anchored to this particular environment.

1.1 The topographic correspondence hypothesis and the sociotopographic model

In line with the Topographic Correspondence Hypothesis (TCH), which hypothesizes that there is a correlation between "a language's system of absolute spatial reference and the topography of the language locus" (Palmer 2015: 210), the significant role played by the environment is clear across the various domains of spatial language in Kalaallisut. The Sociotopographic Model (STM) (Palmer 2016; Palmer et al. 2016) incorporates the TCH to account for the interactions of linguistic structures, language use, cultural practices, and the geophysical landscape, with sociocultural factors and conceptual representations crucially mediating the relationship between language and environment. The influences between environment and people are bidirectional, with the environment shaping sociocultural interaction with that environment, and humans also shaping (building, modifying, changing) the environment through their own actions (Palmer et al. 2017: 484–485).

Both the TCH and the STM would predict that a change in environment will result in a change in the use of spatial language. We find strong evidence to support this in differences in the Yupik-Inuit languages as their speakers have moved across Alaska, Canada, and Greenland. The inherited orientation system surfaces as a

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coastal system for Kalaallit Inuit in Greenland and most other Inuit, and as a riverine system used by Kobuk River Iñupiaq and most Alaskan Yupik (Fortescue 1988: 13–15). The cardinal direction system arises from this environmentally anchored coastal orientation system in Kalaallisut. The transition from a highly coastal system based on the local geography towards a more abstract, cardinal-based frame of reference reflects the history of changing sociocultural engagement with the geophysical environment.

1.2 Language and environment in Greenland

Greenland provides a prime testing ground for the predictions of the TCH and the STM. Languages located on islands can be anticipated to have absolute spatial systems that make use of the distinction between coast/land and water. Greenland is an island, albeit a very large one, with a total area of 2,166,086 km^2 and a majority population speaking an Inuit language. Cities and towns are located on the coast, primarily the western coast (see Figure 1); only Kangerlussuaq is somewhat inland at the head of a fjord. The large interior of the island is uninhabited, with the Greenland ice sheet covering approximately 80 percent of the island. As a result, Greenlanders are overwhelmingly a coastal people, living in a close relationship with the sea, the coast, and the rocky inland terrain. The topography of the coastline is complex, with many fjords, promontories, and small islands. Due to the landscape and resulting settlement patterns, the two main coastlines which run roughly north to south are highly salient aspects of the environment encoded in spatial orientation. Cities, towns, and settlements are not connected by roads or inland waterways; travel between them is by sea or air. In

Figure 1: Map of Greenland (by Carmen Caswell).

northern parts, overland travel has been possible in winter months by dogsled, although that is changing with overall climate change.

Historically and today, there is a synergistic relationship between the people and the land, the sea, and by extension the frozen sea ice in northern regions. Even now, many live a subsistence or partial subsistence lifestyle, and engage with the land and water daily. Even in the capital city Nuuk, the urban center of the country, there is a strong sense of close ties to the land and sea. People go out on boats as often as the weather permits to fish, to hunt, or simply to enjoy the fresh air and open space. Because of the rocky mountainous terrain and inland ice, people look outward to the sea for this extension of space.

There is, of course, a distinction between the built environment and the natural environment in Greenland, but there is also a blurring of the distinction from a linguistic perspective. For example, a number of the demonstratives have dual usages in built environments versus the external environment, such as demonstrative *qanna/qamani* (see Table 1) which refers to the other side of an enclosure or barrier in a built environment (i.e., 'that inside/outside' or 'that in the other room') while, when in the natural environment, it is used to refer towards the interior of a fjord (see Figure 3). As noted by Fortescue (2018), other demonstratives also have a particular usage within the traditional sod house. In Greenland, the outdoor space is an extension of the indoor, built space, and people move between the two as part of their daily lives. This is in keeping with research in other social sciences that views space as socially constructed (Lefebvre 1974).

Thus Greenland is an island with a very specific topography, one that has direct consequences for the spatial orientation system. It is characterized by a culturally specific ontology based on the primary distinction between land and water, which is represented by the landscape domain and is pervasive across other spatial domains, including place names, demonstratives, and the orientation system (Grenoble et al. 2019). Focus on the distinction between land and water follows predictably from a coastal, island environment; however, the way that these categories are conceptualized and linguistically encoded in Greenland is culturally specific and highly anchored in cultural affordances and engagement with the land.

2 Methodology

Fieldwork for this paper was primarily conducted over the course of three trips to Greenland between 2014 and 2017, with time spent in the towns of Nuuk and Sisimiut. Kleist Petrussen lives in Sisimiut full time. Additional fieldwork with fewer speakers was carried out in Copenhagen, Denmark, and Chicago, Illinois. Data was collected through interviews, structured elicitation, walking the land with speakers, and elicitation of travel narratives. Thirty-three speakers in total participated in the research, though not all tasks were performed with every speaker. Speakers' ages ranged from early 20s to late 70s, and most are bilingual in Kalaallisut and Danish with some competency in English.

Our structured elicitation tasks included a landscape photo task, the Topological Relations Picture Series (TRPS) (Bowerman and Pederson 1992), and the Arctic Animals Tabletop Task (AATT), adapted for an Arctic

Table 1: Kalaallisut demonstratives (Absolutive (SG) pronoun/locative adverb).

	Proximal		Distal	Geophysical usage
Horizontal	*manna/maani* *una/uani*		*innga/ikani*	–
Up	*pinnga/pikani*		*panna/pavani*	inland; east
Down	*kanna/kanani*		*sanna/samani*	seaward; west
Inside/Outside		*qanna/qamani* *kinnga/kigani*		inside a fjord south
Coastal direction		*anna/avani* *qanna/qavani*		right along coast; north left along coast; south

context from the Man and Tree task (Levinson et al. 1992). Our landscape photo task presents speakers with photos of Greenlandic landscape and asks how they would point out particular referents or locations using a demonstrative. The TRPS consists of a series of line drawings of spatial scenes, and speakers are asked how to locate one object (indicated by an arrow or by color) with respect to another, targeting topological relations description. Like the Man and Tree task, the AATT presents speakers with photos of objects (animal/hunter figurines and rocks) in different arrangements and orientations across the horizontal plane. One speaker is asked to describe each photo to another speaker, who recreates the scene, invoking frame of reference descriptions. See Section 3.3 for examples.

3 The linguistic encoding of space and topography in Kalaallisut

A particular conceptual representation of space and environment may be seen across several spatial domains in Kalaallisut. The linguistic repertoire available to speakers includes an extensive demonstrative system, relational nouns denoting spatial relationships and directions, a coastally based orientation system, slope terms, spatial locating verbs, wind terms, and local case morphology. These combine with a landscape domain and a closely intertwined set of toponyms, which are most often landscape-based (Grenoble et al. 2019). Here we focus on the coastal orientation system, which may be broadly construed as involving the demonstratives, cardinal directions, and other environmentally based directional terms. The absolute frame of reference (FoR) arises from this orientation system and is highly embedded within the physical environment of Greenland.

3.1 Demonstratives and the orientation system

The Kalaallisut orientation system and absolute FoR is rooted in the demonstrative system, a large and complex demonstrative paradigm. It is anchored to the landscape of Greenland, presupposing a point of reference along the west coast. The morphosyntactic paradigm of stems, shown in Table 1, take a unique set of inflections, including the only prefixes in Kalaallisut, and must be inflected as pronouns, adverbials, interjections, or particles. The main dimensions forming the demonstrative distinctions are distance, verticality, interior/exterior, and coastal direction. On top of these basic spatial meanings, the demonstratives carry further layers of meaning within the landscape of Greenland (see Figure 3). In this way, they form the basis of the cardinal system, combining with other landscape-based directionals to form the orientation system used for description and navigation within the Greenlandic environment.

The up/down demonstratives may be used to refer straight up or down, as in *pinnga* 'that up there' (upstairs) or *panna timmisartoq* 'that airplane (way) up there', or they may be used for oblique up/down, such as something up on a mountain or downhill from the speaker. Figure 2 shows a speaker using demonstrative

Figure 2: *Panna qaqqaq* 'that mountain way up there (landward/east)'.

panna in reference to a mountain (*qaqqaq*), pointing inland. The geophysiography of the coastal island environment is such that the landscape very saliently goes 'up' in the inland direction, and 'down' towards the sea. Thus, the up/down demonstratives, particularly distal *panna/pavani* versus *sanna/samani*, form a landward–seaward axis running perpendicular to the coastline.

Orthogonal to this landward–seaward axis is a coastal axis: *anna/avani* and *qanna/qavani* denote opposing directions along the coastline; while facing out to sea, *avani* points rightward and *qavani* points leftward. Thus, as one moves left/right along the coast, these directions also move around accordingly. The left/right along coast and landward/seaward directions form two opposing axes, both of which may point in any cardinal direction depending upon the location of the origo. Figure 3, based on a sketch made by a speaker during a fieldwork session, shows the mapping of these demonstratives onto the environment (in particular, within a fjord). As mentioned above, the inside/outside demonstrative *qanna/qamani* refers inland from within a fjord, in opposition to *sanna/samani* referring seaward.

The cardinal system (Table 2) emerges from these intersecting axes applied to the west coast of Greenland on a macro scale, where the coastline runs roughly north–south. This maps the axes onto the land such that the 'right along the coast' direction points north, 'left along the coast' points south, 'landward' points east, and 'seaward' points west. The relation between *avannaa* 'north' and demonstrative *anna/avani* (*¿av-*) is more transparent, but *kujataa* 'south' also derives from an earlier demonstrative, *kiv-*, similar to modern Kalaallisut *kig-* (*kinnga/kigani*) 'that outside, south' (Fortescue 1988, 2018). *Kitaa* 'west' and *kangia* 'east' also derive from environmentally anchored directional terms: *kit-* 'out to sea' and *kangi-* 'inland'.

Section 3.3 on frame of reference shows how some demonstratives similarly have a further layer of cardinal meaning based on their geophysical grounding (given in the rightmost column of Table 1).

3.2 Landscape directionals

Other environmental directionals tend to exist in pairs, denoting opposing directions along a geophysical axis; for instance, *timmut/timaa* 'inland' versus *avammut/avataa* 'out to sea' or 'outside'. The directionals *qummut*

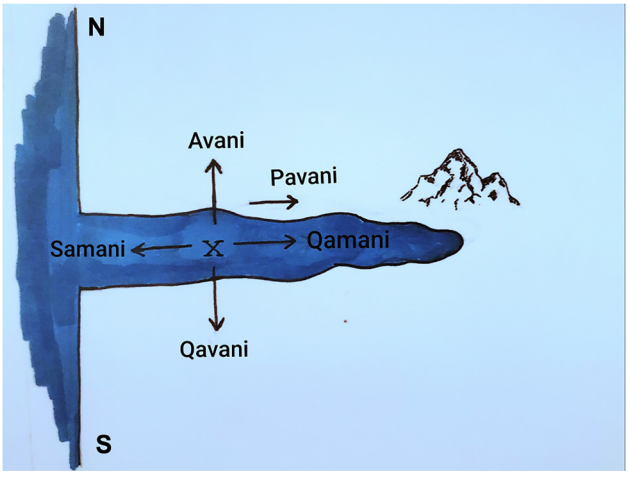

Figure 3: Demonstratives in the fjord.

Table 2: Cardinal directions (Fortescue 1988: 364).

Term	Direction	Coastal configuration
avannaa	'north'	'up the coast'
kitaa	'west'	'towards the sea'
kangia, (tunua)	'east'	'inland'
kujataa	'south'	'down the coast'

'upwards' and *ammut* 'downwards', like the demonstratives expressing verticality, have an abstract spatial meaning but are often used to denote directions within the landscape. Similarly, some relational nouns that denote abstract, topological relations simultaneously have a particular meaning within the local environment; *iloq* 'inside' may also refer to the inland direction inside a fjord similar to demonstrative *qamani*, whereas *silat-* 'outside' may denote the opposite direction (towards the sea from inside a fjord). Figure 4 shows the directional use of *iloq*, as used in a travel narrative describing hunting trips near Sisimiut (example (1)).[1]

(1) *Umiatsiamik* *ilummukartarpugut.*
umiatsiaq-mik **iloq**-mut-kar-tar-pugut
boat-INS **inside**-ALL-go-HAB-1PL.IND
'We travel inland by boat.'

Across these various sub-domains of spatial language, we find particular patterns of spatial representation which show how space and environment are conceptualized in Kalaallisut.

3.3 Frame of reference

The environmentally based spatial terms described in Sections 3.1 and 3.2 are employed by speakers using an absolute frame of reference. A frame of reference (FoR) is an underlying coordinate system used to denote non-topological relationships between objects, for example, the ball is «behind/to the right of/north of» the chair. To locate a figure (e.g., the ball) in relation to a ground (e.g., the chair), the relationship between the two must be encoded; this spatial vector can be derived from an intrinsic coordinate system (based on facets of the ground object), a relative coordinate system (based on axes transposed from the perspective of the speech participants), or an absolute coordinate system (based on axes external to the objects/participants) (Levinson 1996; 2003; Levinson and Wilkins 2006; Pederson et al. 1998; and many others).

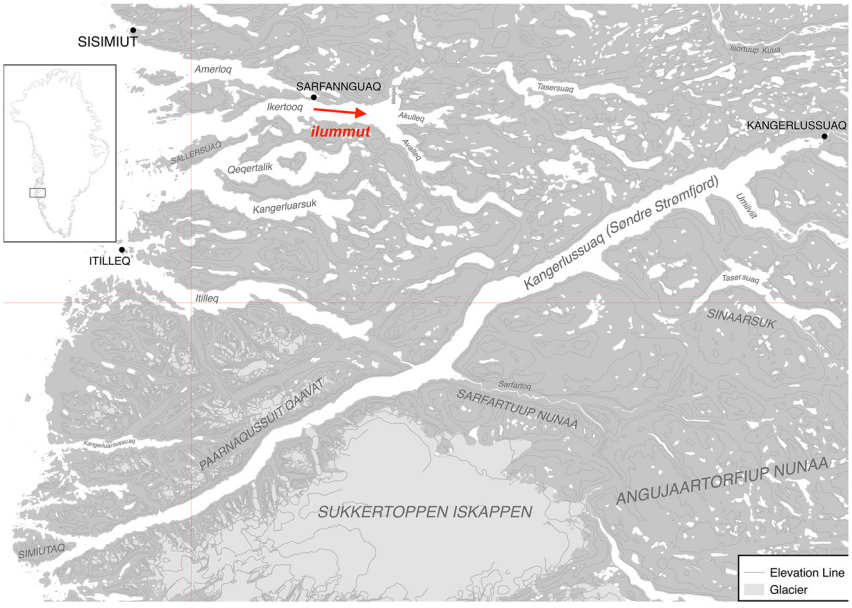

Figure 4: Coastline around Sisimiut and Kangerlussuaq (map by Carmen Caswell).

1 Examples are glossed following the Leipzig Glossing Rules with several additions. Abbreviations used: 1/2/3 first/second/third person; ALL allative; ANAPH anaphoric; DEM demonstrative; DIST distal; ERG ergative; FUT future; HAB habitual; IND indicative; INS instrumental; LOC locative; PL plural; POSD possessed; SG singular; UP up/above.

Although egocentric (relative) strategies are also used for spatial reference, Kalaallisut speakers predominantly utilize allocentric strategies where the anchor of the spatial relationship is located outside of the speech participants, including intrinsic and absolute FoRs (Danziger 2010). Example (2), a description of the TRPS photo shown in Figure 5, illustrates usage of the intrinsic FoR.

(2) *Orpik* *oqaluffiup* *sanianiippoq*.
orpik oqaluffik-p sani-a-ni-ik-poq
tree church-ERG side-POSD-LOC-be-3SG.IND
'The tree is at the side of the church.'

When a more specific spatial vector needs to be expressed, the absolute FoR is often used, both in descriptions of a larger scale (e.g., the location of places or travel within the environment) and in small-scale contexts. Example (3) illustrates the latter, wherein cardinal terms are used to represent spatial relations between figures on a tabletop (in describing how to recreate the setup in Figure 6 to an addressee).[2]

(3) *Ujarak* *ilissavat,* *ilaa* *suu,* *taava* *eqqa …*
ujarak ili-ssa-vat ilaa suu taava eqqa
rock put-FUT-2SG/3SG.IND right yes then near
avannaatungaaniissaaq *piniartoq*.
avanna-a-tunga-a-ni-ik-ssa-aq piniartoq
north-POSD-direction-POSD-LOC-be-FUT-3SG.IND hunter
'You will place the rock, right? Yes, then near … towards the north will be the hunter.'

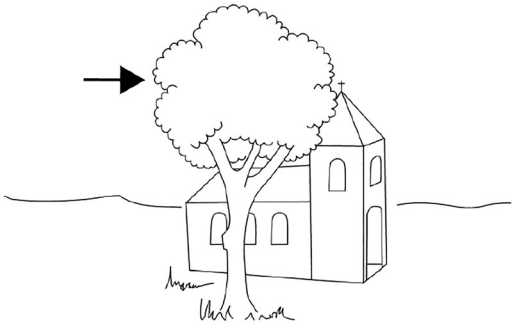

Figure 5: TRPS #49 (Bowerman and Pederson 1992): *Naak orpik?* 'Where is the tree?'.

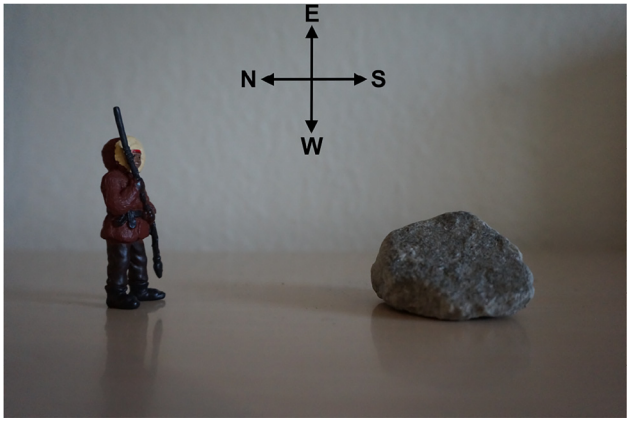

Figure 6: Arctic animals tabletop task picture #10.

2 The cardinal axes shown in Figure 6 are not part of the original AATT picture.

The demonstratives themselves are further integrated with the absolute orientation system in Kalaallisut, as a number of them are a cross-linguistically uncommon type of demonstrative that encodes an FoR, known as *spatial coordinate demonstratives* (Burenhult 2008). Most demonstratives indicate a referent through levels of proximity in relation to the speaker or addressee. The exact location of the referent is deduced, often with the help of pointing or another gesture which provides a vector. In contrast, spatial coordinate demonstratives are more spatially specific because they linguistically project a direction or "search domain", by way of some spatial asymmetry which gives rise to a coordinate system.

Many of the Kalaallisut demonstratives are absolute spatial coordinate demonstratives. Demonstratives like *pinnga/pikani*, *kanna/kanani*, *panna/pavani*, and *sanna/samani* project search domains based on asymmetries of the external environment, such as 'up' versus 'down' and 'uphill' versus 'downhill', while *anna/avani* and *qanna/qavani* do so based on opposing coastal directions. Furthermore, the anchoring of this coastal coordinate system to the wider origo of West Greenland gives rise to a further layer of spatial meaning, as the demonstratives project cardinal directions. Mirroring the cardinal system, the up–down axis maps onto east–west, such that *tappavani* (¡*ta-pav-ani*, ANAPH-DEM.UP.DST-LOC) commonly means 'there in the east' and *tasamani* 'there in the west'. Likewise, the coastal demonstratives map onto the cardinal axis to denote north (*anna/avani*) versus south (*qanna/qavani*); see Figure 7. These cardinal meanings of the demonstratives were noted by Kleinschmidt (1851), indicating the stability of this spatial mapping.

More research needs to be done on the ways that the demonstratives and orientation system may apply to other parts of Greenland, such as South Greenland. The demonstrative system of Inuktun (spoken in North Greenland around Qaanaaq) is highly similar to that of Kalaallisut (Fortescue 1991). The Tunumiisut (East Greenlandic) system, while also highly similar, reflects usage on the eastern coastline with both cardinal axes flipped: *anna* 'that in the south', *qanna* 'that in the north', *panna* 'that up there, in the west', and *sanna* 'that down there, in the east' (Fortescue 1988; Robbe and Dorais 1986). However, our preliminary work to date (McMahan 2022) suggests that the geophysical and cardinal usages of the demonstratives do not transfer outside Inuit territory. One Kalaallisut speaker, an elder and language expert, would not use the coastal demonstratives to reference directions along the coastline of Lake Michigan in Chicago, which also runs north–south. Likewise, we have found no evidence of speakers using the geophysical demonstrative meanings in Copenhagen, Denmark (though they would use the more abstract spatial up/down and inside/outside meanings, particularly with respect to buildings). Further research is needed in this area. In contrast, the cardinal directions (Table 2) appear to be easily applied anywhere and are not tied to coastal configuration.

In sum, the absolute FoR in Kalaallisut spans multiple spatial domains including the demonstrative paradigm and, crucially, emerges out of a non-arbitrary, environmentally anchored system. It is, as argued by Palmer (2015: 223), "not merely anchored in the external world, but [is] motivated by it". The cardinal directions themselves arise from geocentric directions based upon the coastal landscape of West Greenland, a particular representation of space and the environment which appears across the language.

4 Sociocultural engagement with the land

This spatial conceptualization displays an obvious correlation between the topography of the language locus and Kalaallisut spatial language in support of the Topographic Correspondence Hypothesis (Palmer 2015).

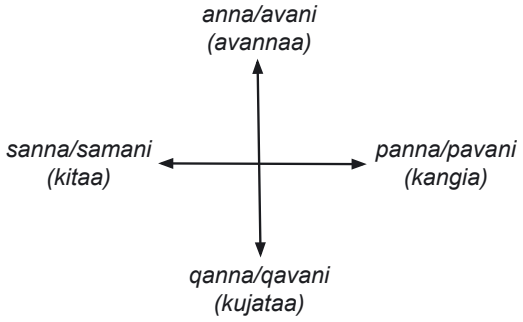

Figure 7: Mapping of the demonstratives onto cardinal directions.

How space is represented in Kalaallisut reflects the unique geophysiography of Greenland, as a large island with an uninhabitable interior and two primary coastlines which are complex in shape with many salient fjords. The Arctic landscape similarly plays an important role in the encoding of space. Rocky permafrost, lack of significant vegetation, long periods of snow, and the presence of sea ice shape the way landscape and environment are encoded through spatial terms, toponyms, and the orientation system. Like the orientation and directional system, the landscape lexicon is structured by a culturally specific ontology closely tied to both the topography of the language locus and the cultural practices of engagement with that landscape. It exhibits a major distinction between water (*imaq*) and land (*nuna*), complex categories which are culturally constructed through a particular engagement with the environment especially based on navigation. The ontological importance of shape and function trumps other features such as size. The shape of landforms, and especially of specific named locations, is salient across shifts in season, with functional importance for their role as landmarks (Grenoble et al. 2019).

All of these features of the Arctic environment and the geophysiography of Greenland itself motivate a particular engagement with the land. The fjords make useful waterways for transportation, especially in contrast to the difficulty of transportation inland. Sea ice and inland snow seasonally make possible other routes of transportation by dogsled and snowmobile. These features shape the subsistence activities that Kalaallit Inuit have relied upon for centuries through the present day, such as the hunting of sea mammals by kayak or from holes in the sea ice as well as large land mammals like caribou and musk oxen. Such aspects of sociocultural interaction with the physical environment play an important role in the conceptualization of that environment and the language through which it may be denoted and indexed.

In the following sections, we focus on this sociocultural mediation between language and environment in line with the Sociotopographic Model. An area in which this becomes very apparent is change; climate change, urbanization, and other factors have contributed to changes in the environment, but even more significant has been the change in sociocultural engagement with it. Interaction with and conceptualization of space and landscape mediate the relationship between language and the environment. When engagement with the environment changes, so may the language used to describe it. Our fieldwork in Greenland has shown shifts underway within the domain of spatial language, mirroring recent and ongoing cultural change.

4.1 A shifting system

Over the past century, settlement patterns and ways of life in Greenland have undergone large-scale shifts. At the beginning of the twentieth century, Greenland was largely still a traditional hunting society, with a subsistence economy based on seal hunting and a characteristic pattern of small settlements along the coast (Sørensen 2007). With the official end of Danish colonial rule, the population became increasingly centralized as people moved into larger towns. This trajectory of urbanization has continued through today, with a third of the total population currently living in the capital Nuuk (Vahl and Kleemann 2019). Similarly, the proportion of Greenlanders hunting professionally has decreased significantly over this period of time (Sørensen 2007; Vahl and Kleemann 2019). Urbanization brings with it a different relationship to the local environment, even though Greenlanders still hunt and travel on land and sea for leisure and subsistence. Combined with new technologies such as GPS, modernization, and globalization, these sociocultural changes in the Kalaallit Inuit's interaction with their environment is intertwined with new ways of conceptualizing and encoding it in language.

In particular, the transition from a purely coastal orientation system to a more cardinal system reflects shifting engagements with the land and influence from external cultures and technologies. Though demonstratives *anna/avani* and *qanna/qavani* emerge from a coastal system, they have undergone a shift such that, for many speakers, their usage has become purely cardinal, fixed to a macro-scale anchoring to the west coast of Greenland. In this way, the absolute FoR has been shifting from a landmark-based system to a more abstract, cardinal system, and this shift in spatial conceptualization reflects shifting engagement with the environment as the directions become disengaged from the local environment. On a similar trajectory is the

ongoing shift away from both geophysical and cardinal meanings in the demonstrative system towards a reduced and less spatially specific paradigm. For example, purely geophysical demonstratives like *anna* were uninterpretable in their pronominal forms by many younger, urban Greenlanders we interviewed. Many of these speakers likewise expressed uncertainty about the directional meanings encoded in the demonstratives beyond verticality and interiority (see McMahan 2022). Along with an increased use of the relative FoR, these changes in Kalaallisut spatial language reflect overall shifts in engagement with the environment tied to broad sociocultural change, including less reliance on traditional subsistence activities.

Additionally, climate change is proceeding rapidly throughout the Arctic. Melting sea ice, glaciers, and rising temperatures are altering the landscape that has anchored Inuit for many generations (Muilwijk et al. 2019). Yet in terms of factors involved in language change, socio-cultural factors outpace climate change. A prime instance of changes in language usage, and a reduction of an environmentally anchored system which relates to climate change, is the use of wind directionals in Greenland today.

4.2 Wind directionals

Kalaallisut wind directionals provide a concrete example of the intersection between environment, language, and socio-cultural practices. These terms encode information about the source location of the wind, as well as its strength, intensity, and temperature. The directional information is based on the coastal orientation system and so interpretation depends on the origo of the speech event; here we describe wind terminology as used in Sisimiut. For many winds the derivation is transparent, with a stem that indicates the source of the wind and a suffix that encodes information about intensity, such as *-nnguaq* 'little'. A small sample of wind terminology is given in Table 3. This list could be expanded considerably, as Kalaallisut word formation is a productive process and new words are easily created, but many wind terms are conventionalized and listed in the dictionary (Berthelsen et al. 2006). There are terms for wind coming from (what in English are) all cardinal directions; Fortescue (1984: 364–365) provides a fairly comprehensive list of the basic (unmodified) terms. But in our fieldwork in Sisimiut, discussion of the winds elicited terms and descriptions from the north, south, inland, and sea. In Sisimiut, the inland regions correspond to east (*kangia*) and the sea to west (*kitaa*), but speakers offered terms that more specifically invoke the land, not the coastal direction (e.g., *nunasarneq* and not *kangisik*), or invoke the sea, and not the direction of facing out to sea (west).

What is striking about the terms is not just that they encode information about the force and direction of the wind, but that speakers consistently defined them in terms of what could broadly be called cultural knowledge. More specifically, the presence of a certain kind of wind was seen as a signal of weather conditions, and speakers provided explanations about what to do when that wind came up. Prime examples are the winds *niggiliuppaa*, *avanniliuppaa*, and *isersarneq*:

Table 3: Wind terminology, by direction.

Direction	Wind term	
From the north	*avannaq*	'cold, strong wind from north' (<*av-*)
	avanngasik	'north wind' (<*av-*)
From the south	*kujasik*	'wind from south' (<*kujat-)*
	taqqavanngaq	'wind from south' (<*qav-)*
	nigeq	'a strong wind from the interior southern region'
From the land	*nunasarneq*	'wind from the land' (<*nuna* '*land*')
	assarneq	'wind from east, up there in the mountains'
	piteraq	'very, very strong wind from inland ice'
From the water	*imarsarneq*	'wind from the sea' (<*imaq* '*sea*')
	isersarneq	'wind in fjord that comes from sea' (<*iser-* '*enter*')

- ***niggiliuppaa***: This is related to *nigeq*, a strong wind from the land; *nigeq* is really cold, it comes down from the ice sheet to the fjords in summer. If *niggiliuppaa* blows when you are out at sea, you will be stuck on the boat, and will need to wait for it to calm down to return. If you are on the land, you need to wait to go out on the boat.
- ***avanniliuppaa***: This wind signals the same situation as *niggiliuppaa*, but it is a wind that comes from the north. Both *avanniliuppaa* and *niggiliuppaa* can be used to describe situations when you are out on the land (as when hunting land animals), but in this case you need to find shelter.
- ***isersarneq***: A wind in a fjord that comes from the sea, not the land. With *isersarneq*, it can be hard to get home but once you get out of the fjord (and out to sea), the weather is nice.

The winds provide important spatial information to hunters out on the land, the sea, or frozen sea ice, especially when it is dark or when visibility is poor. They comprise what is considered a specialized lexicon, best known by hunters, and even elder, highly knowledgeable speakers directed us to hunters to understand them. Hunters compiled inventories of terms, but younger speakers and non-hunters alike could and did understand them, providing interpretations grounded in geophysical terms (their source direction, location, temperature, force, and intensity), and further defining them in terms of cultural and experiential knowledge.

That said, it is unclear how robustly the wind directionals are actually used today. There is broad agreement that the climate has changed sufficiently as to make weather unpredictable, and the direction of the wind is no longer a reliable indicator of weather conditions. Until the last two decades or so, hunters were able to use the winds to orient themselves, on land, sea, or sea ice, and to predict the weather by gauging wind and sky conditions. They are no longer predictors of future weather and behave erratically, with impacts on Greenland's ice and water (Moore et al. 2018). Winds that were historically stable for long periods of time are now unreliable and are part of a larger set of features of climate change, such as melting sea ice, melting glaciers, and rising temperatures (Muilwijk et al. 2019). For changes observed by Inuit in Greenland, see Kielsen Holm (2010), and in Nunavut, Canada, see Laidler et al. (2010). For a broader discussion of indigenous perspectives, see Huntington et al. (2005), and for resilience, see Carson and Peterson (2016).

Climate change is proceeding at an accelerated rate in the Arctic, and yet rapid language change in Greenland is arguably driven more by socio-cultural factors than weather. Fewer people are deeply engaged in life on the land and sea, moving to urban centers like Nuuk where, although they have passive understanding of many wind terms, they do not need them actively. Even hunters rely on modern technology such as GPS to navigate on land and on sea, and sonar sensing in boats to avoid treacherous rocks when fishing and hunting sea mammals. The use of such technological innovations for navigation is further necessitated by changes in climate which have made wind and weather more unpredictable and unreliable, but loss of wind terminology is arguably more directly due to the increase in technology.

5 Conclusions

The Sociotopographic Model is supported by a close analysis of spatial language in Kalaallisut, which is largely based on a coastal orientation system and is highly linked to the geophysical landscape and seascape of Greenland. We find clear correspondences between the environment and the language, particularly the orientation system and the absolute frame of reference, illustrating their being motivated both by the particular language locus on the west coast of Greenland and by the wider Arctic environment.

At the same time, a study of Kalaallisut spatial language emphasizes the important role played by culture in mediating the relationship between language and environment. Inquiry regarding spatial language with Kalaallisut speakers brings forward anecdotes about hunting trips, discussions of environmental knowledge and experience, references to hunters in the family, or remarks about recent changes in usage or understanding. And the role of sociocultural interaction and engagement becomes especially clear within the context of change. Although climate change and other factors are rapidly affecting the Arctic environment, it is people's shifting relationship to that landscape which is more profoundly mirrored in the language.

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