

# Language Development During Interstellar Travel

Andrew McKenzie, Jeffrey Punske\*

Department of Linguistics, University of Kansas, 1541 Lilac Lane, Lawrence, KS 66045 (USA)

Department of Linguistics, University of Southern Illinois, Faner Hall, MC 4517, Carbondale, IL 62901 (USA)

April 30, 2019

## Abstract

This paper explores the consequences that language change might trigger in the languages of crew members during a long journey in space or interplanetary settlement. Languages drift apart as communities grow more isolated from each other, so the long isolation of a traveling community may lead to enough difference to render its language unintelligible to the original community it left. This problem may compound as later vessels bring new crews with their own changed languages to mix with those from earlier crews.

We discuss various aspects that contribute to language change, through comparison to historical Earthbound cases involving some of these aspects, such as the Polynesian settlement of far-flung Pacific islands, and dialect development in relatively isolated European colonies. We also weigh the effects of multilingualism amongst the crew, with or without a common lingua franca in use, as well as the effects of time and the role that children play in language change and creation. As we lay out

possible outcomes, we also suggest possible methods of shaping this development within limits.

## 1 Introduction

When we think of language in space, our minds usually imagine how intelligent non-humans might communicate [28]. However, it is no less crucial to consider what will happen to the humans' language on a long interstellar voyage. Our languages are always changing, no matter what we do, and the necessary conditions for interstellar travel are precisely those that promote significant language change.

These facts raise an important linguistic question for any long-term project, especially if colonization is the goal. For if a trip takes several generations to complete, the language of the vessel community may differ significantly at arrival from that of the passengers at departure. Also, every vessel afterward will see its own language and dialect development, leading to every new arrival speaking a different dialect and perhaps a different lan-

---

\*Corresponding author. E-mail: punske@siu.edu

guage from the others. This question needs to be considered for any mission containing generations-long travel or development.

In this paper we discuss the nature of language change, and look at history to show how much a language can evolve when a part of a speech community isolates itself from other parts for years or even generations. We then look at the facets of modern life that affect language variation, though they cannot stop it. Finally, we explore some additional considerations that emerge from multilingual environments.

We do not focus on any single set of voyage parameters in this paper, because our goal is to introduce readers to broad linguistic issues that might arise. Thomason (2003) addresses some of these questions [31], but makes specific assumptions about crew size and journey length, and makes specific proposals for them. For instance, Thomason suggests that English-language crew would be ideal to achieve genetic diversity within the crew, and given a journey of 200 years, we might not expect major change. However, we will point out that 200 years is long enough for significant changes to occur, especially if the crew is physically and socially disconnected from Earth. These changes might not render the crew language unintelligible to English speakers, but can lead to a new dialect that creates social issues for the crew and any other crews arriving after them. Moreover, these changes will continue during a colonization phase after the vessel's arrival.

We also do not propose much in terms of preventative solutions. Language change is not fully predictable, so there will be a lot of necessary vagueness in a voyage that has to be prepared for. We are nowhere near the point of making concrete policy proposals, ex-

cept for the necessity of sign languages, and an appeal for greater linguistic awareness among crewmembers so they can handle issues as they arise.

## 2 The nature of language change

We begin by introducing readers to what occurs when languages change, focusing on English when possible for the sake of convenient exposition. For this discussion, it is helpful to think a language as a system, or rather, a complex of systems. A dialect is a variation of a language tied to a socially significant geographic region [9]. As such, dialects of the same language exhibit **mutual intelligibility**: Speakers of one can generally understand speakers of the other and *vice versa*. The more the regions are socially close, and the more they are mutually intelligible, the more likely linguists are to call two variations dialects of the same language. Less so, and we are more likely to distinguish two related languages.<sup>1</sup>

Modern linguists tie the systematicity of languages and dialects to elements of cognition or society, but we set that question aside to focus on the nature of changes within these

---

<sup>1</sup>Non-linguists generally employ social factors when distinguishing languages and dialect, with the result that some varieties that linguists generally consider dialects of one language are considered by their speakers as distinct languages, especially if doing so helps maintain distinct social identities. Serbian-Croatian-Bosnian and Hindi-Urdu are the most well-known instances. Conversely, some people consider distinct languages to be merely dialects of one language, usually to promote a unified social identity. The most famous case of this process are the “dialects” of China including Cantonese, Hakka, or Wu, which are not mutually intelligible with Standard Mandarin.

systems.

## 2.1 Aspects of language change

We begin by simply discussing what happens when a language changes.

One of the oldest observations about language change is that much of it is systematic: Changes do not merely affect individual words or sounds, but can affect the grammatical system [20]. A sound /p/ will not only be replaced by /f/ in one word but will be replaced throughout the grammar, in particular systematic environments (for instance, the beginning of a syllable).

Systematicity also applies to changes in other modules of language systems, like word structures (morphology) and sentence structures (syntax). Most European languages are notable for inflectional systems simplifying over the medieval period; this process did not apply to just one word, but throughout the system. Language systems also changed in syntax. For instance, English once put objects before verbs, producing sentences like *The man his cat fed* instead of *The man fed his cat*. In Modern English, verbs precede objects. Again, this was a language-wide shift [34].

Sometimes the change occurs in the underlying processes that build linguistic structures, and is reflected in a series of phenomena. For instance, Early Modern French underwent a series of significant concomitant changes in syntax, which all occurred due to a slight difference in how case is assigned to subjects in the syntax [27]. These three structures are exemplified below by tweaking a grammatical modern sentence (no. (1)) to show what kinds of structures used to be possible. The tweaks (2-4) are all strongly ungrammatical

in Modern French. Before this one syntactic change, French speakers could omit subjects, while Modern French ones cannot (2). French had a “verb-second” structure that requires one word or phrase before the verb. The word or phrase could be the subject, object, or any other phrase (3). In Modern French, the subject must precede the verb. French also allowed simple verb-subject inversion in questions (4), but now only allows it with pronouns (*Comment allez-vous?*).<sup>2</sup>

- (1) *La fille porte les livres*  
The girl carries the books
- (2) *\_\_ porte les livres.*  
(she) carries the books  
(omitted subject)
- (3) *[Les livres] porte la fille.*  
the books carries the girl.  
(verb-second)
- (4) *Porte la fille les livres?*  
Carries the girl the livres?  
(verb-subject inversion)

As with any human process, exceptions abound, notably in highly common expressions whose frequent use shields their lexical entry from grammatical change. English maintains case marking on pronouns like *he/him/his*, a few relic irregular plurals like *children*, and its peculiar series of ‘strong’ verbs like *ran* instead of *runned*. English even retains a handful of archaic object-first expressions like *one swallow does not a summer make, with this ring I thee wed, or till death do us part* (considering *do* as an auxiliary rather

---

<sup>2</sup>Modern German and Dutch still employ verb-second structures in main clauses. English also used to have all of these features. The verb-subject inversion was common until past Shakespeare’s time, hence questions like *Why comest thou?* from *Julius Caesar*.

than the main verb). These expressions are idiomatic and thus protected from systematic shifts.

Some changes work together. A common change of this type is the chain vowel shift, wherein vowels move around the mouth in the language system. For instance, a person might say *bat* in a way that sounds like *bet* (The /æ/ sound moves to /ɛ/, so /æ/ → /ɛ/). Instead of simply making more ambiguity, the person might now say the old *bet* as *butt* /ɛ/ → /ʌ/, and onwards, so *butt* sounds like *bought* /ʌ/ → /ɔ/, and *bought* moves closer to the original *bat* /ɔ/ → /a/. You might think we invented this example but it's real: Around the Great Lakes region in North America, the Northern Cities Vowel Shift is currently taking place, and spreading [20, 23]. The most well-known vowel shift is simply called the Great Vowel Shift, and also occurred in English. From 1400 to 1600, the vowels of English nearly all changed in pronunciation. A word like *tame* saw its vowel move from /a/ (like *father*) to /e/ (like *fame*). The /e:/ vowel in *team* (like *tame*) became /i/ (like *team*) and so on.<sup>3</sup>

Systematic language change is inevitable. That does not mean we can predict exactly which direction these processes will take. Language change is not teleological. Languages do not develop or evolve in any particular direction or with any particular end-stage to approach. Nor are grammatical systems designed or planned. Language use is generally subconscious, and so is language change. It usually occurs piece by piece, imperceptibly to most speakers. Change made by adults and

---

<sup>3</sup>The spelling of English remained mainly the same despite these developments, and that is largely why English vowel spelling is so odd.

teens is often subtly triggered by social factors, while children acquiring a language can push significant change as well.

## 2.2 The rate of language change

The manner of language change is often systematic, but even when it is, the rate of change is not. It is not possible to predict exactly how fast a language will change. Not only do we not know which changes will occur, but there is not a regular rate to measure. Linguists in the 1950s tried a glottochronological approach seeking general consistent rates of language change [25], in analogy to radioactive decay, but language change is more like a biological process than a fully predictable chemical one.

We can be certain, though, that just one lifetime suffices for significant differences to emerge, especially in a smaller community. We even see this speed in larger communities. In English, it is increasingly common for speakers to end statements with a rising intonation. This phenomenon, called **uptalk** (or sometimes High Rising Terminal), is often mistaken for a question tone by those without it in their grammars, but it actually sounds quite distinct [15] and indicates politeness or inclusion [14]. Uptalk has only been observed occurring within the last 40 years, but has spread from small groups of young Americans and Australians to most of the English-speaking world, even to many Baby Boomers who had not used it themselves as youth.

Given more time, new grammatical forms can completely replace current ones. About two hundred years ago, the English sentence *My house is currently being built*, which employs the progressive passive, was ungrammatical. To describe this scenario one only said *My house is currently building*, which

is stoutly ungrammatical to modern speakers [33].

An even more recent development is the *get*-passive (*My child **got promoted**, my house **is getting built***), which has a subtle meaning difference from the *be*-passive. The *get*-passive is a common and cemented feature of modern English, but its widespread use is actually new—it postdates the first heavier-than-air flight. Likewise, the ubiquity of *get* in use with other predicates (*e.g.*, meaning ‘become’ as in *get angry*) is younger than the Enlightenment [4].

These changes to language are grammatically significant, and while no single change would make a vessel’s language incomprehensible to us back on Earth, each little change to the system adds up until the system no longer obviously resembles the original. In addition, some systematic changes can render a language nearly incomprehensible to past speakers in short order. Most of the Great Vowel Shift took place in less than 200 years, between Chaucer’s time and Shakespeare’s. Chaucer in print is extremely difficult for modern English speakers to make out. If it’s read aloud, few would recognize it at all. Even Shakespeare in 1600 could not have heard it without learning a different language—and Shakespeare’s dialect is quite different from modern ones as well [10].<sup>4</sup>

---

<sup>4</sup>A reviewer points out that in 200 years, it is not terribly likely that a language will change to the point of non-intelligibility. However, some changes affect intelligibility more than others, and a vowel shift—which often takes less than 100 years—affects it greatly.

## 2.3 Social factors in language change

We cannot consider language systems without also considering the people who know them. That requires a look at cognition, but it also requires examination of social factors. Our species is a social one, and language as a trait permits us to communicate in ways that other animals simply cannot, to our general benefit.

The main reason that languages diverge is that their speaking communities cease speaking to one another. Each little change adds up over time, until two communities speak distinct dialects. As divergence continues, **mutual intelligibility** is reduced to the point that speakers no longer understand one another, and their varieties are now distinct languages.

Languages also change when they come into contact with new languages, and show convergence. Words get borrowed (like *football* from English), and grammatical features leak over. In some regions, so many features are shared that the region forms a distinct linguistic area (or **Sprachbund**). The Balkans are a well-studied Sprachbund, due to features including postposed definite articles [32]. In most European languages with definite articles, articles precede their noun phrases: *the woman*, *la femme*, *die Frau*. However, many languages and dialects of the Balkan region, no matter what language family they’re from, have articles that follow the noun phrase and are morphologically attached to it, as if English had *woman-the*. Notably, some Baltic Slavic languages (like Bulgarian) have this construction, even though other Slavic languages (like Russian or Czech) lack definite articles altogether.

These factors can be accelerated when a community is small. Divergence accelerates

language	plural form	
Macedonian	<i>čovək-ot</i>	man-the
Bulgarian	<i>student-ăt</i>	student-the
S.E. Serbian	<i>žená-va</i>	woman-the
Romanian	<i>porc-ul</i>	pig-the
Aromanian	<i>om-lu</i>	man-the
Albanian	<i>mik-u</i>	‘the friend’

Table 1: Article forms in the Balkan Sprachbund (from Tomić 2006)

because it is easier for a small community to cut off contact with others. As divergence from other communities takes place, convergence towards one another accelerates because small communities allow for a change to rapidly become the norm, and because a small community might be greatly affected by a larger community’s language.

Another social factor affecting change is language identity. People often use language or dialect as a method of belonging within a community (the one that speaks that way), and will unconsciously adjust their own speech to more closely match their peers. As a language variety becomes distinct from others, community members accentuate the differences, and the differences become the norm as a badge of belonging.

These social factors are well observed occurring around the world, in all types of societies, so we can predict that they will apply to any crew on an interstellar vessel, even if we cannot predict exact changes. The physical isolation of an interstellar voyage fosters divergence from Earth varieties, especially as social isolation grows without any no other communities to grow convergent toward. This isolation also offers an ideal environment for a speech community to form, with crew members’ speech converging [29].

### 3 Language Change in Exploratory Contexts

In this section we will discuss a few historical instances that are analogous to the interstellar scenario. Crews of intrepid voyagers travelled long distances to form new communities cut off from others who spoke their language. Given just a few hundred years, these communities’ language developed into new dialects and into completely new languages by diverging from other varieties and converging on a new one. The paths of divergence and convergence depended on the social conditions of the voyagers as well as the environments they landed in.

#### 3.1 Isolated Oceanic Settlement

Austronesian expansion and settlement, particularly Polynesian settlement across the southern Pacific, provides an ideal mirror to space exploration for a number of reasons: It includes human exploration and settlement into the unknown, and the groups undertaking this journey experienced isolation from external human influence. Polynesian languages are descended from a single hypothesized common language, or **proto-language**, called Proto-Polynesian. Linguistic, genetic, and archeological evidence provides somewhat different answers to the origin site of this language [16, 30]. Polynesian deep-sea settlement likely began between 1500–1000 BCE [16, 18]. Settlers reached distant and hard-to-reach locations such as Hawai’i and Easter Island around 400-500 CE and New Zealand around 1000 CE.

Being the first humans to live in these places, the Polynesian settlers were largely

isolated from other languages. Krupa [18, 19] notes that this isolation impacts the linguistic situation.

“First, the Polynesian languages are notable for an extraordinary transparency of their phonemic systems and phonotactic structures, and second, Polynesia is, due to an almost total lack of external influence, a sort of linguistic laboratory where hypotheses on various linguistic changes can be verified” (Krupa 1973:15).

Recent research finds that far-flung Polynesian settlements were not fully cut off, and that many conducted exchanges between each other [7]. Nonetheless, the various speaking communities were largely isolated from other ones, and new, mutually unintelligible varieties emerged. A spatial crew or colony would also not be fully cut off from other speakers, because of long-distance communication tools, so we can expect over time that the language(s) of our space explorers will undergo a similar shift relative to the Earthbound language users they left behind.

### 3.2 Non-isolated Oceanic Settlement

The relative isolation of Polynesian settlements stands in contrast to the history of Malagasy, which is spoken in Madagascar. Despite its location near mainland Africa, Malagasy is a cousin of the Polynesian languages, as both belong to the larger Austronesian language family. Madagascar was settled by Austronesian settlers from the East Indies around 500 CE, and their language would develop into modern-day Malagasy. However,

Madagascar’s proximity to southern Africa has shaped the language’s development via contact-induced change with nearby speakers of Bantu languages [11, 2]. This shaping has affected both vocabulary and grammatical structure, including Malagasy’s full-fledged tense system, and the introduction of word-final vowels [3]. For instance, Malagasy *ùlunã* ‘person’ derives from Proto-Malagasay *\*ulun*. In related Borneo languages like Maanyan, these words still generally end in consonants (*ulun*). Vowel-final words are a well-known feature of Bantu, and Malagasy is the only language in its historical group where they are prevalent. The exact history and timing of this influence has been a matter of debate [38], but it is clear that neighboring languages have significantly affected Malagasy development.

As a whole, we may expect that a multi-generational crew’s language would shift in the ways common in internal-changes within a language. The lack of consistent, external pressures or influences on the crew language would make this very similar to the case of Polynesian exploration and language change, while the presence of any external influences at the point of arrival would predict a development more like Malagasy.

### 3.3 19th-century colonization

We have no historical record tracing how Polynesian or Austronesian languages changed, and must trace their development through the present-day descendant languages. More recent examples offer a record to examine, and also shed light on dialect development through contact. English speakers of various dialects emigrated to New Zealand in large numbers the mid-1800s. There, they built a relatively small colony largely isolated from other En-

glish dialects [35]. Once this divergence occurred, the various dialects quickly converged to make a new standard within three generations, in a levelling process that Kerswill calls **koinéization** [17].

A similar situation occurred when German settlers from a variety of regions emigrated to Texas in the United States, forming communities that remained mainly German-speaking until World War I. In three generations, the dialects of these German speakers had begun to coalesce [8], but the koinéization was not as complete as it was in New Zealand, perhaps due to the minority status of the German communities being surrounded by English-speakers. Nonetheless, Texas German became fairly distinct from other varieties of German spoken back in Europe.

The time periods in these cases have only been long enough to allow the development of distinct dialects rather than languages, but they merely involved a few decades of relative isolation. And the process of dialects levelling and merging began on the months-long sea voyage. For a years-long voyage, we can expect the dialects to begin to merge, and for a generations-long mission, we can expect a new dialect distinct from all others to become solidified. Given enough generations, we can expect the crew and colonists to have formed a distinct language altogether— without even taking into account changes back on Earth.

## 4 Considerations for Modern Exploration

The examples of historical exploration demonstrate what is likely to happen to an isolated crew's language over a long interstel-

lar voyage. However, several crucial aspects of human culture relating to language have arisen since those times, and these changes induce significant effects on the outcomes of language change. The three we shall discuss are language policy, universal compulsory education, and telecommunications.

### 4.1 Language Policy

In ordinary lives, people can speak any language they please, and it suits them well. When it comes to international cooperation and professional communication, that choice becomes practically constrained. A common language or set of languages is generally crucial to cooperation, and on a mission, cooperation is crucial to success. Consequently, in many domains, interested parties agree to employ a **lingua franca**, a language chosen to be the common one for the mission. In international aviation that language is generally English. English serves in science as well, though Latin served that purpose for many years. French was the lingua franca of Western diplomacy; Chinese that of the Far East. In space missions, the choice is localized based on context: English is used aboard the ISS, while Russian is used in the Soyuz craft to reach it, although a lack of clear policy has led to some confusion [5].

Language policies that promoted national languages formed a key component of nationalism throughout the 20th century, but in the 21st, policies have shifted toward the preservation and promotion of endangered minority languages. Any colony or long-term voyage will need to set a course in terms of language policy that takes these trends into account. The oldest form of language policy is mandating the use of an **official language** in

government business. Over the years, as government functions have spread into more and more aspects of life, so the effect of one or more official languages has grown. The most important one for language development has proven to be education.

## 4.2 Education

One key distinction of modern times from the past is that nearly all children go to school. Recall that children are a significant driver of language change. During the course of acquiring languages, they figure out the systems they are exposed to from their peers and from adults. As they figure out a language system, they adjust it slightly. As the children age into adolescence, their innovations often endure [21]. After the older have speakers passed on, the changes become part of the language or the dialect—Koinéization of an immigrant dialect begins among adults, but kicks off in earnest once children begin to acquire it as native speakers.

The role of children in language acquisition has grown more prominent in language policy since school is now the main locus of child socialization, and thus of language development [13]. Consequently, language policies often focus on education, taking advantage of the need for *some* language or dialect to serve as the medium of instruction. Many governments have employed education to enforce the use of a dominant language [24], to defensively protect a minority one [26], or to deliberately eradicate minority languages [1]. Forcing children to use one language can contribute to the end of acquisition of others. A multilingual vessel will have to set its education policy carefully.

Although education plays a role in promot-

ing or eradicating language varieties, it does not greatly affect the change of languages that continue to be acquired. In fairly monolingual jurisdictions, education tends to promote a prestige dialect above others, rather than a prestigious language. However, it rarely causes that dialect to supplant local ones. In some cases, like Standard German, few people use the prestige dialect natively. In Finland, nobody does. In both cases, everyone learns the prestige variety in school.

The promotion of a dialect is generally accompanied by prescriptive stylistic rules, which slow the rate of change in the written language, but do not significantly slow the less prestigious local dialects from continuing to change. If the process continues unchanged, the two forms will diverge. For instance, written/literary French is strictly preserved by linguistically conservative language academies, and still employs forms that fell out of use in spoken language over two hundred years ago, like the *passé simple*. It also employs question forms that speakers use only in a few dialects. Contrast the written *Quand arriva-t-il le vaisseau?* ‘When did the vessel arrive?’ to the spoken *Il est arrivé quand, le vaisseau?* The growing distinctions have led many linguists to consider spoken and written French to be distinct dialects [12], before even considering regional variations.

On a long voyage, or in a colonization situation where everyone spoke a single language (say English for the sake of example), we would probably see the same situation unfold. Even if the onboard schools rigorously maintained the teaching of “Earth English,” the children would develop their own Vessel English dialect, which would diverge from Earth English over time. The divergence would be aided by isolation, since the children would

not need to enter the wider workforce. Convergence towards a unique variety would be aided by the sense of identity the dialect would offer to the vessel's occupants. Indeed, after several generations, the mission participants might have almost no need to learn the Earth English dialect except to read operation and maintenance documentation and other historical documents. In a multilingual crew, this process might unfold for every language involved.

### 4.3 Telecommunications

Since the Industrial Revolution, communities have grown less isolated from one another. This interconnection has exploded during the Information Age, as telecommunications and air travel expose people to other accents and languages more than ever before. Contact slows or prevents divergence, and national media promotes a single identity with a neutral dialect, so one might conclude that dialects are blending together over time now.

Contrary to that conclusion is actual observation, which finds a more complex picture. While some dialects are levelling off toward a standard dialect promoted by education and mainstream media, other dialects are diverging as a marker of socioeconomic identity—a way to stay distinct amid a homogenized culture [6, 22]. Many cases involve novel regionalizations of standard varieties (*e.g.* Estuary English, Poldernederlands), while others involve maintaining or accentuating non-standard varieties.

Such identity marking may become a critical early factor in linguistic divergence when two-way communication is possible between Earth and the ship or colony at relatively short time lapses. As the crew forms a 'regional'

identity separate from the Earth-bound support team, we would expect to see reflexes of this separation in their language use. Also, if the crew is large enough, tasks may be divided in ways similar to socio-economic strata in Earth-bound societies. It is therefore possible that multiple ship-based varieties would emerge as markers of identity.

These emerging dialects would develop despite continued communication with Earth, at least for relatively near missions. However, Earth languages might not be forgotten, even if only a few people used them. As the distance grows between Earth and the crew, we might instead see the development of fossilized, older forms of the Earth languages in specialized or even ritualistic use. As time and distance increase between Earth and the ship or colony, direct two-way communication will become impossible, as messages may be received years after transmission. With the divergence of languages on the ship relative to Earth, and with the Earth-bound languages still changing, such messages are likely to employ a preserved form of the common, pre-change version of the languages in a standardized, ritualized way. Such preservation may be viewed as analogous to the preservation and use of dormant languages in liturgical or other religious settings, like the use of Latin by the Catholic Church, Biblical Hebrew in Jewish traditions, Classical Arabic in Islam, or Sanskrit in the religions of India.

## 5 Multilingualism on board

For the purposes of exposition we have mainly assumed a monolingual crew, but in the modern era of international cooperation, a multilingual crew is almost certain. Reliable univer-

sal automatic translation that can keep up with the full breadth of language use still resides in the distant realm of science fiction, so communication policies will need to be set. Every question previously discussed will occur for each of the languages on board. Thomason's suggestion of a monolingual-English crew is aimed at promoting communication first and foremost [31]. However, as of the 21st century, linguistic diversity and the co-requisite preservation of cultural identity also require important consideration [36]. Even if one language predominates, it will also be practical to select crew in part for skills in multiple languages.

## 5.1 Ensuring crew communication

Obviously, the entire crew will need to communicate with one another, unless the vessel can hold several hundred people. This is the problem faced by international organizations like the United Nations, the European Union, or OPEC. Some groups choose a single lingua franca spoken by the nation at 'heart' of the organization (English for the British Commonwealth, or Russian for the CIS), while others choose one that is common amongst members, like Modern Standard Arabic for the Arab League. Some economic organizations like OPEC use English as a lingua franca due to its status in international business. Others rely on simultaneous translation, especially organizations with legal force. The EU famously translates into the official languages of all its members, while the UN limits itself to six of most commonly spoken ones around the world. Simultaneous translation takes up valuable resources that a spaceship likely cannot spare, so the crew members will need to be multilingual. This solution has proven helpful for

current ISS missions, but can it be scaled up to a mission where ten different languages are spoken?

## 5.2 Sign Languages

Even if one nation sent a monolingual crew on a long voyage or to form a colony, there would end up being some kind of multilingualism due to the birth of congenitally non-hearing children. Congenital hearing loss occurs at a rate of over two per thousand births [37]. These children can acquire sign languages, which any child can acquire as easily as hearing children can acquire spoken ones. Sign languages are as complex and complete as spoken languages, but completely distinct from them. American Sign Language, for instance, is completely unintelligible with British Sign Language, and is actually more like French Sign Language. Sign languages also change over time. The certitude of congenital non-hearing will entail the requirement of signers participating in the mission, to ensure that non-hearing children are not deprived of language acquisition. In order for a child to acquire a sign language, there must be signers signing to and around them.

## 6 Conclusion

This paper has considered some of the outcomes concerning language during a long interstellar voyage, or a colonization scenario. While crisp predictions are impossible due to the nature of language change, we can predict that significant changes will likely occur within a single generation. Eventually, the language or languages of the crew will diverge from those on Earth. If they start out with mul-

tiple languages, those will perhaps converge towards each other. After enough time we will consider the crew's speech to have formed new languages.

If we send multiple crews to a colony, the problem could compound upon each crew's arrival. History shows that a months-long voyage is not enough time for a new variety to develop, so after a colony has established its own dialect or language, most new arrivals will assimilate to the colony's speech. For those who don't assimilate, their children certainly will. However, if the voyage is years or generations long, each new vessel will have its own dialect and dialect community, unlike that of the colony they arrive at. Perhaps they will have formed a new language altogether. Either way, every new vessel will essentially offload linguistic immigrants to a foreign land. Will they be discriminated against until their children and grandchildren learn the local language? Can they establish communication with the colony ahead of time to learn the local language before arrival?

Given the certainty that these issues will arise in scenarios such as these, and the uncertainty of exactly how they will progress, we strongly suggest that any crew exhibit strong levels of metalinguistic training in addition to simply knowing the required languages. There will be need for an informed linguistic policy on board that can be maintained without referring back to Earth-based regulations. Not to mention, the voyage would provide a significant natural experiment for linguistic science, if crew members are capable of conducting it. Metalinguistic awareness would not only crucially aid the mission but would add to its scientific value as well.

## References

- [1] David Wallace Adams. *Education for Extinction: American Indians and the Boarding School Experience, 1875–1928*. University of Kansas Press, Lawrence, KS, 1995.
- [2] Alexander Adelaar. Loanwords in Malagasy. In Martin Haspelmath and Uri Tadmor, editors, *Loanwords in the World's Languages: A Comparative Guide*, pages 717–746. Mouton de Gruyter, Berlin, 2009.
- [3] Alexander Adelaar. Malagasy phonological history and Bantu influence. *Oceanic Linguistics*, 51(1):123–159, 2012.
- [4] Liselotte Anderwald. *Get, get*-constructions and the *get*-passive in 19th-century English: Corpus analysis and prescriptive comments. In Sebastian Hoffmann, Andrea Sand, and Sabine Arndt-Lappe, editors, *Exploring Recent Diachrony: Corpus Studies of Lexicogrammar and Language Practices in Late Modern English*, volume 18 of *Studies in Variation, Contacts and Change in English*. VARIENG, Helsinki, 2017.
- [5] Megan Ansdell. Language protocols in international human spaceflight: Time for a common tongue? *Space Policy*, 28(1):2–6, 2012.
- [6] Peter Auer, Frans Hinskens, and Paul Kerswill, editors. *Dialect Change: Convergence and Divergence in European Languages*. *Convergence and Divergence*

- in European Languages.* Cambridge Univ. Press, Cambridge, 2005.
- [7] James Belich. *Making Peoples: A History of the New Zealanders, from Polynesian Settlement to the End of the 19th Century.* University of Hawai'i Press, Honolulu, 1996.
- [8] Hans Christian Boas. *The Life and Death of Texas German.* Duke University Press, Durham, NC, 2009.
- [9] Charles Boberg, John Nerbonne, and Dominic Watt, editors. *The Handbook of Dialectology.* John Wiley & Sons, Hoboken, N.J., 2018.
- [10] David Crystal. *Pronouncing Shakespeare: The Globe Experiment.* Cambridge Univ. Press, Cambridge, 2005.
- [11] Otto Christian Dahl. Bantu substratum in Malagasy. *Estudes Océan Indien*, 9:91–132, 1988.
- [12] Cécile de Cat. *French Dislocation.* Oxford Univ. Press, Oxford, 2007.
- [13] Penelope Eckert. *Linguistic Variation as Social Practice.* Blackwell, Oxford, 2000.
- [14] Penelope Eckert and Sally McConnell-Ginet. *Language and Gender.* Cambridge Univ. Press, Cambridge, 2003.
- [15] Janet Fletcher and Jonathan Harrington. High-rising terminals and fall-rise tunes in Australian English. *Phonetica*, 58:215–229, 2001.
- [16] Geoffrey Irwin. *The Prehistoric Exploration and Colonisation of the Pacific.* Cambridge Univ. Press, Cambridge, 1992.
- [17] Paul Kerswill. Koineization and accommodation. In J.K. Chambers, Peter Trudgill, and Natalie Schilling-Estes, editors, *The Handbook of Language Variation and Change*, pages 669–702. Blackwell, Oxford, 2002.
- [18] Viktor Krupa. *Polynesian Languages: A Survey of Research.* Mouton, The Hague, 1973.
- [19] Viktor Krupa. *The Polynesian Languages: A Guide.* Routledge & Kegan Paul, London, 1982.
- [20] William Labov. *Principles of Linguistic Change*, volume 1: Internal Factors. Blackwell, Oxford, 1994.
- [21] William Labov. *Principles of Linguistic Change*, volume 2: Social Factors. Oxford Univ. Press, Oxford, 2001.
- [22] William Labov. *The Politics of Language Change: Dialect Divergence in America.* University of Virginia Press, Charlottesville, 2012.
- [23] William Labov, Sharon Ash, and Charles Boberg. *The Atlas of North American English.* Mouton de Gruyter, Berlin, 2006.
- [24] Foued Laroussi and Jean-Baptiste Marcellesi. The other languages of France: towards a multilingual policy. In Carol Sanders, editor, *French Today: Language in its Social Context*, pages 85–104. Cambridge University Press, 1993.

- [25] Robert Lees. The basis of glottochronology. *Language*, 29(2):113–127, 1953.
- [26] Leigh Oakes and Yael Peled. Language policy and planning in Quebec: a brief overview. In *Normative Language Policy: Ethics, Politics, Principles*, pages 22–47. Cambridge University Press, 2017.
- [27] Ian Roberts. *Verbs and Diachronic Syntax*. Kluwer, Dordrecht, 1993.
- [28] Bridget Samuels and Jeffrey Punske. Where does universal grammar fit in the universe? human cognition and the strong minimalist Thesis, 2018. Presented at International Space Development Conference 2018.
- [29] Daniel Schreier. Language in isolation, and its implications for variation and change. *Language and Linguistics Compass*, 3(2):682–699, 2009.
- [30] Soares, Pedro, Teresa Rito, Jean Trejaut, Maru Mormina, Catherine Hill, Emma Tinkler-Hundal, Michelle Braid, Douglas J. Clarke, Jun-Hun Loo, Noel Thomson, Tim Denham, Mark Donohue, Vincent Macaulay, Marie Lin, Stephen Oppenheimer, and Martin B. Richards. Ancient voyaging and Polynesian origins. *The American Journal of Human Genetics*, 88:239–247, 2011.
- [31] Sarah G. Thomason. Language change and cultural continuity on multi-generational space ships. In Yoji Kondo, Frederick Bruhweiler, John Moore, and Charles Sheffield, editors, *Interstellar Travel and Multi-Generation Space Ships*, pages 100–103. Apogee Books, Burlington, Ont., 2003.
- [32] Olga Mišeska Tomić. *Balkan Sprachbund Morpho-syntactic Features*. Springer, Dordrecht, 2006.
- [33] Larry Trask. *Why Do Languages Change?* Cambridge Univ. Press, Cambridge, 2009.
- [34] Carola Trips. *From OV to VO in Early Middle English*. Number 60 in *Linguistik Aktuell/Linguistics Today*. John Benjamins, Amsterdam/Philadelphia, 2002.
- [35] Peter Trudgill. *Dialects in Contact*. Blackwell, Oxford, 1986.
- [36] UN Educational, Scientific and Cultural Organization (UNESCO). UNESCO Universal Declaration on Cultural Diversity. In UNESCO Digital Library at <https://unesdoc.unesco.org>, 2002.
- [37] Betty Vohr. Overview: Infants and children with hearing loss-part I. *Mental retardation and developmental disabilities research reviews*, 9(2):62–4, 2003.
- [38] John U. Wolff. *Proto-Austronesian Phonology with Glossary*, volume I and II of *Cornell Southeast Asia Program Publications*. Cornell University Press, Ithaca, NY, 2010.