Language, nuclear waste and society

The preservation of knowledge over vast periods of time and its relevance for linguistics

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This article is part of a diptych of texts concerned with what light philological, linguistic and exegetical scholarship can shed on the vexing and (literally) dangerous question of how we human beings as a species can communicate into the future information about nuclear waste storage, i.e. the question and field that has come to be known as *nuclear semiotics*. In the other (counterpart) article,[1] I discuss possible roles that could be filled by a traditionalized intelligentsia in preserving information about nuclear waste disposal, and the problems caused by transmission and reinterpretation of ancient textual or ritual material. One of the aspects pointed out there about what we know concerning such elite groups (especially religiously motivated ones) is the fact that they have a tendency of preserving not only vast amounts of text and pieces of ideology making up world views and symbolic universes, but also of transmitting knowledge of ancient languages, the understanding of which would be necessary in order for vital information to be transmitted into the distant future.

This article focuses more specifically on this latter issue: what the study of ancient languages and their transmission into the present world can teach us about the possibilities of keeping our texts about nuclear waste readable and understandable through coming millennia, and, conversely, what this question has to say about the classical fields of philology and historical/comparative linguistics. The point of this article (and its counterpart) is not to suggest this or that course of action for the preservation of "nuclear semiotic" knowledge, but rather to discuss a few of the problems that the question raises. Some of these matters have been pointed out before, but others are perhaps more unique and especially important for textual and linguistic historians to ponder, in order to acquire what may be a new perspective on their own disciplines.

"Reconstructing the modern world and its languages from the future"

Discussing the matter of communicating knowledge about nuclear waste disposal into the future – from the perspective of historical linguistics and

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philology – puts one in a philosophically strange but perhaps somewhat exhilarating, illuminating and challenging position of having to view our "modern" culture as an ancient one. One has to transport oneself, as it were, into the future and try to "look back" at the world of the 21st century, at its languages and textual material. What would our culture, our languages look like from a vantage point lying vast amounts of time into the future? What parts of the world would be remembered? Which – if any – of our languages would be understandable, and to whom? What view would the people of such a future have of our present world? Would we be viewed as ancient, almost god-like beings, as unenlightened barbarians, or as despicable tyrants? Or would we be forgotten altogether? Must our attempts to communicate with such a future not factor in these vastly differing possible views of our world?

For scholars trained in historical and comparative linguistics and fields such as comparative Indo-European mythology, the usual activity and methodology is to try to reconstruct words and ideas that were spoken and thought thousands of years ago, based on the common characteristics shown in linguistic materials from later times. In this case, however, this form of "reconstruction" has to be inverted and applied to *future* stages of language and communication. What we have to do, then, is not only to "reconstruct the future backwards" but even to "reconstruct" what the people of that future may one day think of us – and of our languages.[2]

Such an exercise must perforce be extremely speculative, but we really have no choice – if we are to deposit nuclear waste and let it lie for tens of thousands of years, we *must* speculate. Indeed, the entire enterprise is one based on speculation. And all we have to base such speculation upon is what we know of human language and written communication during that relatively short time period during which such communication has existed and is legible and understandable today.[3]

Of course, the question of how and if we will be able to communicate our "nuclear waste information" into the future is not simply (or perhaps even mainly) a linguistic one *per se*. It is to a large extent a question of semiotics and social history; the matter of social groupings and their role in transmitting knowledge systems such as the one discussed here is taken up in greater detail in the other article of the present "diptych", when I discuss ideas of "atomic priesthoods" and their (possible) functions as transmitters of knowledge about nuclear waste. The linguistic aspect is, however, important in and of itself, as it will have to utilize knowledge based on the well-developed discipline of historical linguistics "turned around its axis" into the future, an exercise which may prove important and illuminating for that discipline itself. However, even though this article is focused on the questions of writing and language, it should be emphasized that I do not labor under the misapprehension that the question of nuclear waste information is exclusively linguistic in nature. However, it

puts the insights that may be gleaned from the historical study of language into a very special perspective. There is, in a sense, a parallel between the question of communicating nuclear waste information into the far future and the attempts that have been made at communicating with putative extraterrestrial life-forms. In both cases, we are trying to communicate with people about whom we know next to nothing.[4]

The nuclear waste question points to major philosophical problems concerned with what it actually means to communicate. It is concerned with communicating linguistic information without having any idea about who the recipient of that information might be. Thus, it points to problems not only relating to historical linguistics but to philology in general. The other article of the "diptych" used the example of a Phoenician funerary inscription and the great differences between "sender" and "receiver" of the messages contained therein, and the same point is relevant here, too. All philological study of old texts is perforce reading of textual information that *we* were not meant to read. The Old Testament scholar Phyllis Bird once wrote that what we are doing when reading ancient biblical writings is actually not taking part of a conversation but "overhearing" it.[5] If this is so, any communicating into the far future will have to constitute educated guessing about how that "overhearing" will one day look. This question is social and semiotic. But it is also linguistic, as the knowledge that we want to transmit is quite technical in nature and will thereby have to take verbal form. It does, in a way, highlight some questions about the nature of linguistics and philology that are rarely asked otherwise. Therefore, the reader is advised to think of this article not only (or, perhaps, even mainly) as a contribution to the discussion about how to communicate into the future but also as a discussion about the role of linguistics and philology and about the methodological limits of these fields.

Writing systems and scholarly/scientific genres

One thing that the 5 000 year history of writing and human literature teaches us is that the material on which one chooses to write greatly affects the probability of one's words surviving, legible and understandable, into the future. It also affects the genres of the writings that are preserved. Some of the most active literary cultures we know — such as the Roman and the Greek — have in certain respects failed in preserving certain types of texts, as the writing materials that they used (mainly papyrus and vellum) are easily destroyed due to simple, environmental factors. It was mediaeval monasticism and similar milieux that saved much of these literatures by constant and deliberate copying of texts deemed worthy thereof,[6] but this of course also resulted in a process of selection, in which certain types of texts were not preserved for posterity (or not as well preserved as others). Ideological biases thus made themselves immediately

heard in the process of textual transmission. This, it must be admitted, can appear to be a rather self-evident matter that perhaps should not need to be pointed out, yet it bears repeating that scribal activity is perforce an ideological one.

Examples of this process are found already in antiquity, for example when texts in the common Hellenistic dialect of Greek, Koiné, were not copied and preserved for the future to the same extent as texts written in the high-status, neo-Attic language (which emulated the linguistic style current in Athens in the 5th and 4th centuries BC). The "common Greek" dialect that spread across the entire eastern Mediterranean area in the wake of the conquests of Alexander the Great was not deemed "pure" enough for its texts to be copied and preserved for posterity.

In that case, the criteria for the selection of which texts to pass on were focused not on the contents of the texts but on their outward form, viz. the language in which they were written. This of course means that this choice of language in the texts perforce involved a type of censorship, which implies that our knowledge of Hellenistic literature in Greek is marred by selection-bias from the get-go. It is worth remembering that this selection was due not to any innate factors having to do with the "quality" of the texts as such but rather with (seemingly arbitrary) aesthetical considerations about which form of the Greek language appeared more beautiful and pure. This highlights the rather anarchic quality such developments often take and the difficulty inherent in trying to apply "rational" methods of preservation. The rationality of the preserver may be suspect, as unconscious selection biases may be at work within the minds of those marking out certain texts as worthy of preservation – and one has even less control over what may happen in the future, when societal, scientific, scholarly and aesthetic norms may radically have changed in ways unimaginable to us.

The world's first known writing system, Mesopotamian cuneiform, can (despite its great age and cumbersome nature) serve as an example of how important it is to employ a durable writing medium if one hopes that one's words and ideas are to survive the test of time. Throughout its lifetime (which lasted for 3 000 years – that is, longer than the Latin alphabet has been in use), cuneiform was primarily intended for writing on clay tablets which were subsequently fired or dried, a material that may perhaps appear "primitive" to modern people. However, it is the very choice of this highly durable material that has made possible the very extensive archaeological preservation of texts in cuneiform languages (primarily Sumerian and Akkadian, but also Elamite, Hittite, Luwian, Hurrian, Urartian and – if one includes other writing systems derived from classical cuneiform – Ugaritic and Old Persian as well). This extensive preservation of course has its roots in the fact of fired clay being such a durable material, one very well suited for the "jigsaw puzzle work" of reconstructing

the physical clay tablets, which have often been broken or damaged. Preservation of papyrus or vellum – the materials of choice for Graeco-Roman literature – is more precarious and depends to a greater extent upon surrounding environmental factors, such as climate, etc. (burned clay runs less risk of being completely destroyed than does papyrus or vellum).[7]

In this context it is important to note that many materials that people today often regard as very durable can have serious drawbacks from the standpoint of textual preservation. This is the case with both bronze and limestone/marble, two materials that are often used as materials for ancient texts. The problem with these materials is that they can easily be "recycled", which often happened during the Middle Ages: inscribed bronze objects were melted down and limestone was used for mortar. Burned clay is, however, difficult to recycle and thus suited for preserving text for a long period of time.

Cuneiform was a very complex writing system, with many hundreds of different signs (in its oldest versions over a thousand) that often could have many different meanings (logograms, syllabic characters, determinatives), but due to the durability of the writing material we today possess a virtually inexhaustible corpus of text in cuneiform languages (mainly Akkadian and Sumerian), great amounts of which are still unpublished and await the attention of Assyriologists. This puts modern methods of storing information digitally – on USB flash drives and different types of optical discs – in a somewhat unfavorable light. The use of durable writing materials has granted modern scholarship access to texts from the "everyday life" of cuneiform cultures in a way very different from how texts have been preserved from the Graeco-Roman world.

As mentioned above, the texts most commonly read today in Greek and Latin were preserved mostly because of the work of mediaeval scribes. The situation in the case of cuneiform languages is different.[8] The mediating factor there is modern archaeology and its discoveries. In the case of cuneiform culture, private letters, contracts, storage accounts, economic documents and other forms of "everyday texts" have been preserved to a very large extent and form a natural part of a modern day curriculum of the study of these languages.[9] One should, however, note that it is of course not only contracts, letters and account-keeping that have been preserved in cuneiform: we possess detailed descriptions of Mesopotamian mathematics and astronomy, which was highly advanced for its time and formed the background of all later development in these areas. Again, because of the writing material, these scholarly texts in some cases appear rather different in their genres than comparable texts from the Graeco-Roman world: whereas the scholarly texts in ancient Latin or Greek that Western students are often used to reading are in many cases meticulously crafted treatises, the texts preserved from Mesopotamian scholars are not seldom

"use texts", applying the principles of the various scholarly and proto-scholarly disciplines to specific, concrete cases (although there are also "abstract" texts). There are Greco-Roman parallels to this situation, to be sure (specifically, one can mention scholia, marginalia and similar phenomena), but still, more of the scientific and proto-scientific texts from Greco-Roman antiquity are "edited treatises" than is the case with cuneiform literature. Thus, due to the writing material, we have a large amount of "ancient scholarship in practice" preserved from cuneiform cultures, but more texts of a purely theoretical nature in Ancient Greek and Latin.[10] There is a vast amount of inscriptional material in Latin and Greek, but the contents of these are more rarely examples of "applied scholarship from a specific situation", whereas there is rather a lot of this sort of material from cuneiform cultures. If we simply write down on durable material the specific "warnings" about nuclear waste that we wish to communicate to the future, they can risk falling into the trap of later generations mainly keeping the "use" part of the equation alive, as we cannot be certain of the "mediaeval monks and scribes" (so to speak) keeping their more abstract principles alive. This illustrates the possibility of future peoples only reading the "results" or concrete applications of our contemporary scientific principles without necessarily understanding the postulates upon which these results rest. This, of course, is a recipe for misunderstanding, and needs to be factored in when one thinks about how and on what to record information for the future. We may have to imagine a situation in which someone in the future reads a description of a nuclear waste site without at all understanding the scientific basis of what he or she is reading, which may create great opportunities for re-interpretation, or (as we may view it) misunderstanding.

As an interesting example of the role cuneiform played as a carrier of cultural values, we can look at the following almost moving words composed by (or perhaps on behalf of) the Sumerian king Shulgi (*floruit* ca. 2100 BC), describing the role of that king as disseminator of high culture to the most "barbaric" of lands:[11]

> *i_3-ne-eš$_2$ ^{d}utu ud ne-a-a kur dumu ki-en-gi-ra nu-zu-ba sa-dur$_2$ kaskal-bi-še$_3$ šu la-ba-ĝal$_2$-la-ba zag-ba ka-inim-ma lu$_2$ nu-gub-gub-ba šeš di$_4$-di$_4$-la$_2$ lu$_2$-inim-ma-be$_2$-ne dumu-saĝ inim u$_3$-tud šir$_3$ kad$_4$ inim kad$_4$-bi-im šir$_3$-ĝa$_2$ mul-an-gin$_7$ gu$_3$ im-de$_2$-e-ne inim-ĝu$_{10}$-ta* […] *ki im-tag-tag-ge-ne*
>
> Now, by the Sun God, this day! – and in lands that do not know the children of Sumer, in lands in which roads are not laid, in which eloquence/writing does not exist, my younger brothers shall be witnesses [to this] – [Shulgi], the firstborn son, is a creator of words, a binder-together of songs, a binder-together of words. They will pronounce my songs like the stars of the sky, before my words they will bow to the ground …

Because of the choice of clay as a writing material, it seems that Shulgi was correct in his prediction. Being able to read his self-laudatory remarks some four thousand years later is certainly impressive. This type of memento seems necessary when contemplating how information about nuclear waste disposal can be preserved. Yet, four thousand years is a minuscule amount of time in this context; when discussing nuclear waste disposal, we are talking about tens of thousands of years at the very least.

Regardless of our technological advances – the printing press and digital technology – we are perhaps in certain respects in a worse position than was Shulgi when it comes to preserving our ideas and words for the future. We do, however, have a few advantages that he did not. The invention of printing was of course enormously helpful in disseminating mass-produced written material, and it also created a need for linguistic standardization, which may aid in keeping written material readable. Yet, even ancient cuneiform culture included standardization efforts: one example of this is the rise of the common, standardized dialect of Akkadian known as Standard Babylonian during the latter half of the second millennium BC (it later came to dominate much of Akkadian writing during the first millennium). And modern digital methods of storage and dissemination of information, as mentioned above, constitute what is perhaps the most volatile form of written communication ever to come into being. In its most extreme forms – email communication and cloud-services, which have no physically readable representation whatsoever in their unprocessed state – it is entirely dependent upon the survival of our form of society, which does, after all, seem like a rather optimistic thing to hope for in the long run. The more physical the writing material, the greater the chances of preservation must be. This is certainly the case as pertains to Greek or Roman texts as well, as evidenced by the great amount of ancient inscriptions preserved in these languages, but it is definitely interesting that few of these inscriptions deal with technical/scientific subjects as applied to "use" situations, as these would usually have been written on less durable material.

Future linguistic development?

A much more difficult – and, indeed, impenetrable – question is that of future linguistic evolution or development. Given the enormous timescales involved in the question of preservation of knowledge related to nuclear waste management, there is really no saying how a relevant linguistic situation ought to be imagined. Will any of the main languages of today be in use in, say a hundred years? Probably. Five hundred? Who knows. And in ten or twenty-five thousand years? The question is pointless. The mind boggles. One could justifiably argue that the relevant ques-

tion is not what language human beings will be speaking in such a remote future but whether or not they will exist at all.

Our knowledge of human linguistic history has some semblance of certainty for no longer a period than, say, the last ten or fifteen thousand years, or perhaps a little more than that. Such a timeframe is one that one sometimes sees for the proposed unity of the Afro-Asiatic linguistic family, that is, for the existence of the hypothetical Proto-Afro-Asiatic language (from which the Semitic, Egyptian, Cushitic, Berber, Chadic and Omotic languages ultimately derive).[12] A similar time-scale is applicable to the Anatolian hypothesis of Indo-European origins advocated by Colin Renfrew, who puts the Indo-European linguistic unity somewhere around 7000 BC.[13] (I, personally, find this hypothesis to be highly unlikely; an Indo-European origin during the late Neolithic and early Eneolithic in the Eurasian steppes seems much more likely to me – ca. fifth or fourth millennium BC.).[14] Even if one accepts such far-reaching and utterly speculative proposals such as that of the existence of a so-called Nostratic macrofamily of languages (including, among others, the Indo-European, Afro-Asiatic, Dravidian and Altaic linguistic families), one still comes nowhere near the time-depths involved in the proposed preservation of technical information necessary in the case of nuclear waste disposal. And it should be noted that all the examples above concern proto-languages that are not in any way directly attested in writing but are only accessible using the methodology of comparative/historical linguistics, the results of which – though being an impressive tool to which I wholeheartedly lend my support – are in a constant process of reevaluation.

Even if one ignores such overarching questions as whether or not the human species will even be in existence as a dominant life-form in twenty-five or thirty thousand years, the question of which languages that future population will be able to understand is, as said above, unanswerable. There is a common misconception among the general public (and also among certain scholarly trained individuals) that the survival of languages or language families is in some sense due to those languages or families being "fit" or "adapted" in some quasi-Darwinian sense – i.e. that languages such as Akkadian, Sanskrit, Latin, Chinese, Arabic, French or English (that have persisted for a long time and have been spread over large territories) are somehow especially "strong" or "viable" languages, possessing some (undefined) qualities that set them apart. To a linguist, this idea is positively ludicrous. The above-mentioned languages do not share any specific characteristic that makes them especially "viable" in comparison with others: indeed, few languages could be more typologically dissimilar than, say, Sanskrit and Chinese, yet both have been studied and perpetuated for millennia.

No, the survival or lack thereof of a specific language is determined not by the linguistic peculiarities of that language but by the political, religious

and societal connections and associations that the language has been given. Sanskrit became a classical language because it was the preferred choice of the Brahmin orthodoxy; English became a dominant language because of the expansions of the British Empire and (post-World War II) because of the economic and military hegemony of the United States of America. None of these factors have anything to do with the linguistic characteristics of Sanskrit or English. To be sure, the "social history" of a given language can definitely influence certain aspects of that language as used in speech and/or writing, but this is then a secondary development at most. In the same vein, the decline of the use of Yiddish has absolutely nothing to do with the in itself enormous idea of Yiddish being an "incomplete language" or a "creolized jargon" but is a consequence of certain historical developments, first and foremost of course the Nazi Holocaust, which physically annihilated millions of its speakers.

All of this means that it is quite futile an exercise to try to predict the languages of the future based on some "magical" property inherent in the languages of today. The main question is this: what politico-historical processes will occur and affect the linguistic map of the world? Wars or economic disasters can bring one nation to the forefront and another to its knees, and the ensuing situation of political and economic domination will quickly influence – or determine – what languages people will use in a specific time and place. Even in cases in which the spoken language is kept the same, external developments can affect such matters as choice of script. Historically, such changes have often been tied to changes in religion (the adoption of the Arabic script for Persian is a clear example of this), but sometimes other factors can determine such change as well. One instance of this can be seen in the fact that the script today most often referred to as the "Hebrew alphabet" is, strictly speaking, rather to be regarded as Aramaic. It was adopted for use for Hebrew as well as a result of the Babylonian exile in the 6th century BC, while the older, Palaeo-Hebrew, script started gradually to fade into disuse.

This means that even if one were in the future somehow to preserve or retain a spoken language for a long period of time, there is certainly no guarantee that this language would be written in the same script. And, of course (and this is one of the main points), the language itself would change. To illustrate these great differences to readers who perhaps may not have a background in comparative/historical linguistics, I would like to draw attention to the development of the word occurring in modern English as "am" (as in "I am"). If one reconstructs this word back to its hypothetical Proto-Indo-European source, one arrives at the word $*h_1esmi$, which is certainly very different from the English word in use today. The word appearing in English as "sun", in Swedish as "sol" and in German "Sonne" ultimately derives (with some changes) from Proto-Indo-European $*séh_2ul$, with the genitive $*sh_2uéns$.[15] Matters may be very complicated;

the structural forms of inherited words may have changed in various ways in the different daughter languages, or the words have been entirely replaced with other terminology. Who, for example, could have predicted the Swedish word *bil* (meaning "car"), which is made up of a combination between the Greek morpheme *auto-* combined with the Latin *-mobilis*, which became *automobil* and was subsequently shortened to *bil*?[16] The probable age of the above-mentioned reconstructed Proto-Indo-European forms is perhaps 5500–6500 years – which shows the immense problems inherent in keeping our texts readable for tens of thousands of years. If one were to present a modern reconstruction of how a simple Proto-Indo-European sentence might possibly have sounded, one arrives at something very, very different from English, one of its many direct descendants:

> **wiHros weuk^{w}et: potnih$_{2}$ h$_{1}$ék^{w}om espéket.*
> "The young man said: '[my] wife saw a horse'".

Such is the difference that linguistic history has created in only something like 6000 years. If one wants a purely English example of the same process, one can look at the following (authentic) sentences in Old English (Anglo-Saxon) concerning the death of William the Conqueror in AD 1087:

> *Reowlic Þing he dyde, and reowlicor him gelamp. Hu reowlicor? Him geyfelade, and Þet him stranglice eglade. Hwæt mæg ic teollan? Se scearpa deað Þe ne forlet ne rice menn ne heane, seo hine genam. He swealt on Normandige on Þone nextan dæg æfter Natiuitas Sancte Marie, and man bebyrgede hine on CaÞum æt Sancte Stephanes mynstre.*[17]
>
> A terrible thing he did, and an [even] more terrible thing happened to him. How [much] more terrible? He became ill, and it ailed him awfully. What can I say? Sharp death, that leaves neither rich men nor lowly, took him. He died in Normandy, on the next day after the day of the birth of St. Mary, and he was buried at Caen at St Stephen's monastery.

Without knowledge of historical linguistics, such a text would be as good as undecipherable to a speaker of modern English, and such will probably be the case with our writings in the future, unless our languages get fossilized as classical tongues.[18] The point of all of these examples (as speculative as they are) is simply to underscore the immense difficulty in making any kind of prediction about any linguistic situation in the far future.

Historical linguistics as a tool of survival

All of this brings us to the following, perhaps somewhat surprising, conclusion: one of the main necessities in keeping information about nuclear waste readable into the future is to keep comparative-historical linguistics

alive as a practiced discipline. It is only through historical linguistics that we today have the possibility to read languages such as Akkadian, all knowledge of which died out two millennia ago. The same can be said for Ugaritic and, to an extent, languages such as Ancient Egyptian and Gothic. If humanity wants to provide any opportunity for our far-future descendants to understand what we are trying to tell them about nuclear waste deposits and similar phenomena, we must endeavor to keep alive both a traditional intelligentsia with an ongoing knowledge of the relevant "classical languages" (the "elite groups" mentioned above) and knowledge systems – and an analytical and historical form of linguistic (and "exegetical") scholarship equipped to serve as a corrective to this "traditional" understanding of the textual material when it has become changed or corrupted – or when the chain of traditional transmission has been broken. Sometimes such correction can be partly built into the tradition itself. One thinks here of the "error correcting" methods used in transmitting the Vedic texts over millennia, when reciters devised various special and alternate methods of reciting the texts, multiplying specific syllables in ingenious and standardized ways in order to provide automatic error correction for possibly corrupt passages.

The fact is that problem spheres such as that involving preservation of information concerning nuclear waste provide a very clear illustration of the necessity of historical/comparative linguistics as a field of expertise in the future. If humanity does not keep this discipline alive and well-studied, the textual materials that we consider to be of very high importance will fade into incomprehensibility and obscurity. The peoples of the future will need to be able to work philologically with texts that *we* produce, and this will of course involve many branches of philology: textual reconstruction (if necessary), etymology and historical linguistics as well as exegetical work.

Non-predictability in linguistic development

One must also keep in mind that while historical linguistics using the comparative method is an excellent tool (and, indeed, the only functional one) for reconstructing earlier forms of language, there is no testable and reliable way of projecting this method into the future, in the sense of "reconstructing what English will be like in 500 years". One example of this problem can be found in the oft-mentioned fact that the languages of Western Europe seem to have developed in the direction of less morphological complexity. In theory, one could extrapolate from such a tendency the idea that in, say, 500 or 1000 years, the English language will (if still extant) acquire a typological structure similar to that of Chinese, which is almost completely isolating (has almost no inflectional morphology at all). However, a quick look at linguistic history will soon contradict such

an idea, or at least make it much less clear-cut. The seeming reduction or disappearance of inflectional morphology in Western European languages has been greatly influenced by their fixed orthographies and writing systems, which easily reflect such reductions, but cannot as easily show the appearance of new inflectional categories if they are present in the spoken language, as these would in most cases be regarded as substandard dialectalisms or possibly as being slangish. When the normative writing system collapses, however, one can in many cases detect that new morphological patterns have emerged *sub rosa*, so to speak.

One of the clearest examples of this process can be found in Coptic, which is the most recent version of the Ancient Egyptian language. As later phases of hieroglyphic Egyptian developed, it looks to the reader as though the classical morphology were collapsing, replacing past tense forms with expressions of the type "s/he did [so and so]", thus reducing the inflections of the verbs themselves and necessitating the use of auxiliary verbs. However, when the old hieroglyphic writing was replaced with an alphabet derived from the Greek one – and the language entered its Coptic phase – one can suddenly see that these constructions using verbal auxiliaries had surreptitiously developed into a completely new (and rather complex) morphological system, which included a typologically unusual system of so called second tenses, which emphasize adverbial and circumstantial parts of a sentence. The development of the Coptic verbal system "on top of" the collapsed remnants of the classical Egyptian one shows that caution is necessary when trying to predict the future structure of a given language.[19]

Neither can one predict phonological developments with any certainty. Two very closely related languages, Swedish and Danish, have vastly different phonological systems even though they were essentially the same language – Old East Norse – a mere thousand years ago. Danish developed a very special phonology, including pharyngealized vowels and the hard-to-describe glottalic suprasegmental feature known as *stød*, which does not occur in Swedish.

These facts point again to the preservation of classical languages and historical linguistic scholarship as a discipline being central to keeping important textual material readable in the future. One ought also to keep in mind the necessity of linguistic redundancy – the need for preserving texts in many different languages and media – as there is no way to predict the socio-political changes that influence the use of one particular language instead of another in the future.

The attested history of written, human language also points in another direction concerning the feasibility of making one's texts readable in the future. This is the question of vocabulary. Most ancient languages are scantily attested: only a few of the great, literary languages of antiquity are represented by large quantities of text – and texts of many different

genres. This type of happy deviations from the norm can be found in cases such as Akkadian, Latin, Greek and Sanskrit – in which we possess startling amounts of differing texts representing many different "lexical subsets" of the languages in question. In the case of other ancient languages of which we have a record, the situation is much less impressive: a rather extreme example is that of Etruscan, a language in which there is a large number of preserved inscriptions. Most of these are, however, very short indeed, and a very large majority is made up of funerary texts commemorating dead persons using extremely stereotyped language, repeating the same pieces of vocabulary time and again. This means that, despite the relatively extensive textual corpus (at least compared with many other languages that are mostly epigraphically attested), our knowledge of the Etruscan language is still relatively slight. No more than about 300 words have more or less securely known meanings, and the few extant texts that deal with other subjects than dead upper-class individuals use vocabularies that diverge so widely from that of the main (funerary) corpus that modern scholarship has a very hard time understanding them.

This shows that – even if one manages to keep some of our currently written languages understandable in the far future – this understanding may well be marred by circumstance and coincidence, reducing the understanding of specialized vocabulary. Technical vocabulary may possibly stand the risk of not being understandable. To be sure, the Etruscan example shows that sometimes one very specific field of technical vocabulary may be preserved (in that case, terms such as *svalce*, "lived", *lupu*, "is dead", *śuθi*, "grave", *hinθiu*, "infernal, chthonic", and *mutna*, "sarcophagus" abound), but this would give us nothing to go on when trying to read texts of other genres.[20] A similar case can be found in the preserved texts in Mycenean Greek (Linear B), the contents and vocabulary of which is highly specific.

Another example of this problem can be found in the much more well-known (and continually well-studied) case of Biblical Hebrew, the vocabulary of which is defined entirely by the contents of the Hebrew Bible. The Old Testament scholar Edward Ullendorff once published an article with the illustrative title "Is Biblical Hebrew a language", in which he argued that what we have preserved in the text of the Hebrew Bible is but a fraction or subset of the language that was once spoken (and, it may be presumed, written) by the ancient Israelites, and that it is thus problematic even to speak of that mass of text as constituting a "language" in any real sense.[21] Such may very well one day be the case with English, Chinese and other "modern" languages as well. In the future, it could theoretically become the case that the technical vocabulary of today's English, for example, would be viewed by the philologists of the future as a kind of analogue of Homeric Greek, a *Kunstsprache* which was semi-constructed and not used as a spoken medium (which would in a sense be

true, as a matter of fact). Technical, "nuclear waste English" could be studied in the future not as a part of trying to find out what we did with our nuclear waste but as a purely linguistic exercise; maybe the vocabulary and way of expressing ourselves in that context will be viewed as a type of epic, narrative language, very interesting to be sure, but only from a linguistic and literary point of view. A bizarre thought, definitely, but who knows? In fact, there has already been at least one clear example of an "epic *Kunstsprache*" in the classical sense being applied to the nuclear waste question. This is in the well-received movie *Into eternity* (2010)[22] by Michael Madsen, in which the director addresses a theoretical future viewer with the following words:

> Once upon a time, man learned to master fire, something no living creature had done before him. Man conquered the entire world. One day, he found a new fire, a fire so powerful that it could never be extinguished. Man reveled in the thought that he now possessed the powers of the universe. Then in horror, he realized that his new fire could not only create, but also destroy. Not only could it burn on land, but inside all living creatures, inside his children, the animals, all crops. Man looked around for help, but found none. And so he built a burial chamber deep in the bowels of the earth, a hiding for the fire to burn… into eternity.

This passage, of course, in consciously meant to use poetic/narrative language to illustrate the nuclear waste question, but what if this (again, bizarrely) were to become one of the texts future people have to work with when trying to understand what our generations have done? And what if they then draw the conclusion that nuclear waste information in general is epic or legendary in character?

Thus, it may be fruitful to consider what type of vocabulary one uses in recording the relevant information for posterity, also bearing in mind the question of what other types of text may be preserved for the future in the same language and which thus possess a probability of being used as future comparative material. Scholarship concerning the meanings of ancient texts is rarely focused on one text alone – whether consciously or unconsciously, data from other textual entities are very often brought into the analysis. If one is conducting a study based on etymological comparison this is, indeed, necessary by definition, as one is then keeping not only other texts but other languages in mind when carrying out one's analysis.

If one wants to keep one's texts readable, one therefore will have to ask oneself what *other* types of texts have a reasonable chance of being preserved in large quantities and being readable in the future and then try to compose one's texts in ways that – to as large an extent as possible – use vocabulary and stylistics typical of this "shared preserve". As such predictions are well-nigh impossible to make with any certainty, one would do

well to go for redundancy not only in the choice of many different languages and individual pieces of text, but also in using different stylistic and lexical patterns for expressing the same ideas, thus hoping that at least one or two of these "micro-languages" will be kept understandable in the future.

Again, this underscores the need to be aware that texts written today may be read in very different and unexpected circumstances. Future readers may expect surprising pieces of vocabulary. Imagine, if you will, a situation in which the central, known remains of the English language would be, say, terms for kitchen utensils or traffic signs. And then imagine a future reader trying to make sense of complicated texts concerning nuclear waste and its dangers.

The above lines of inquiry have all concerned questions of what historical linguistics and the study of ancient languages have to say about the preservation of important textual material for the future. However, the reverse question is also relevant: that is, how can the "preservation of nuclear waste information" question impact these classical disciplines?

To begin with, one should not discount the very fact of the "nuclear question" putting the relevance of historical linguistics and classical philology into an entirely new perspective. All too often, these academic disciplines have been regarded as being of mere antiquarian interest, in many cases making them appear unattractive to "the people with the money". Many arguments have been made that suggest that the study of languages such as Latin, Classical Hebrew, Sanskrit, Sumerian – or Proto-Indo-European – constitutes an unnecessary part of Academia, a type of "hobbyist" scholarship devoid of value. Cases such as the present one concerning nuclear waste storage show that these ideas are quite simply not true. A vital question for the future not only of humankind but of all living creatures on the face of the earth definitely needs to take into account the knowledge amassed by classical philologists and students of ancient languages. This in itself is a sobering prospect.

The same issues suggest themselves in relationship to other disciplines that have formed a necessary part of our modern rediscovery of Hittites, Mesopotamians and other ancient peoples (and their writings). I am referring, of course, to Archaeology and History, the development of which forms the basis for many types of philology having anything to work with in the first place. It is only to be hoped that these disciplines will be kept alive as well.

Questions such as these also force philologists and comparativists to consider the implications of their craft – and its limits. Can we with our honesty intact make any sort of predictions concerning the languages that will be spoken or written in hundreds, thousands or tens of thousands of years? Probably not, but the question must be posed and reflected upon – and this is a perspective that is not often taken by philologists and

linguists during their ordinary work. It also forces one to consider the fact that the processes that historical linguistics study are at work at the very time in which the philologist is operating. This is, of course, a trivial statement known to all scholars in the field – of course sound laws are currently operating and linguistic structures changing, but it is one thing to state this self-evident matter and quite another to reflect upon the implications that this may have for the future of the textual and linguistic evidence of today's world. When one has to factor in the risk of painful and brutal death for future human beings, the stakes of linguistics become that much higher.

All in all, I believe that the meeting between the nuclear waste question and historical linguistics and philology has something to teach both parties. It shows an interesting cross-section between the study of ancient things and the contemporary and even future world. Contemplating how things that we write down and store in the present can be (mis-)interpreted in an imagined future world may serve as a welcome corrective to some of our own ideas concerning the past. When ancient humans wrote texts for the future to read, they cannot possibly have imagined what that future would look like, and what "linguistic perspective" the peoples of that future would view them in. Such it is with us also. We are, perhaps, not as much the historical center of the world as we would like to be, and the question of "nuclear linguistics" helps us to ponder this simple fact. However, the two hundred years that we possess of scholarly and historical study of the way in which language works puts us in a position perhaps a bit more enviable than that of King Shulgi and his contemporaries – not because the world that we live in (and its linguistic culture) is more "perfect and evolved" but because we have certain tools that can be used to reflect upon that culture and its historical position. And this fact underscores the need for preserving such a tradition of scholarship into the very, *very* far future. We need to be read – desperately. Our never-ending craving to communicate here becomes a question of the preservation of life, and this forces us to reflect about ourselves – and our languages.

There can be no question about the fact that historical linguistics and philology are necessary – vitally necessary, in fact – for making our messages about nuclear waste understandable. Making use of their results becomes an integral part of a great semiotic undertaking, and (as I have argued above) this influence can run both ways. Comparative and historical philologists – and scholars of philology and textual study in general – have much to learn from performing the mental exercise of inverting their methodologies into the future, as the question of nuclear waste information forces us to do. For once, we as philologists are talking neither of texts that are "dead" nor of texts that have been "kept alive", but of texts that have not yet started living. Texts whose life is of vital importance to all life as we know it.

Summary

Language, nuclear waste and society. The preservation of knowledge over vast periods of time and its relevance for linguistics. By Ola Wikander. The article discusses the impact of comparative/historical philology upon the question of nuclear semiotics, i.e. the field of how humanity is to communicate information about nuclear waste storage into the distant future and its (presumably human) inhabitants. It also turns this perspective on its head and discusses possible insights in the other direction – what nuclear semiotics can teach historical linguistics and philology. It is argued that the "nuclear waste question" provides one of the clearest examples of the purely practical importance of human reflection upon the historical development of language and writing.

Keywords: Nuclear waste, nuclear semiotics, historical linguistics, comparative linguistics, Etruscan, Coptic, Indo-European, Biblical Hebrew.

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Notes

1. Ola Wikander: "Don't push this button. Phoenician sarcophagi, 'atomic priesthoods' and nuclear waste", in *Vetenskapssocieteten i Lund*. Årsbok (*Yearbook of the New society of letters at Lund*) 2015, 109–124.

2. I use the term "reconstruct" quite deliberately here, regardless of the word being oxymoronic when applied to future events and phenomena, in order to point out the strange position historical linguistics is put in when discussing this type of question.

3. In this article, I have deliberately chosen to discuss only *written* communication (and the linguistic and material questions related to it), as opposed to other kinds of "signs" and similar ways of communicating into the future. More general discussions of semiotics in relation to the nuclear waste question can be found e.g. in the early report by Thomas Sebeok (Thomas Sebeok: *Communication measures to bridge ten millennia* [Springfield, 1984]). It should be noted that I disagree with many of the arguments put forth in that report, for example the idea of creating a sort of "atomic priesthood" that could perpetuate the "legend" of the nuclear waste storage (this idea is analyzed and problematized in the other article of the present "diptych"). Also, for the present purposes, it must be emphasized that I do not share Sebeok's (p. 20) apparently rather dismissive attitude to the comparative value of ancient scripts and languages. This type of data is actually the *only* real comparative material we have for the present question, and so it must be used, however nebulous the results.

4. On the question of communication with extra-terrestrial beings, I refer to Douglas A. Vakoch (ed.): *Archaeology, anthropology, and interstellar communication* (Washington, 2014), published by NASA, especially chapters 4, 5 and 6 (by Ben Finney/Jerry Bentley, Richard Saint-Gelais and Kathryn E. Denning, respectively), which deal specifically with the questions of decoding messages and understanding languages. I want to thank Cornelius Holtorf for bringing this reference to my attention.

5. Bird talks about how one should translate ancient (in her case, biblical) texts in terms of helping a modern audience "to *overhear* an ancient conversation, rather than to hear itself addressed directly." (Phyllis A. Bird: *Missing people and mistaken identities. Women and gender in ancient Israel* [Minneapolis, 1997], 243).

6. The role of mediaeval scholarship in transmitting ancient literature as a relevant illustration of the problems inherent in communicating about nuclear waste in the future

was also pointed out in Jacob May: "The last of the Canterbury Tales. Artificial intelligence in the fifth millennium" in Eva Hajičová, Miroslav Červenka, Oldřich Leška & Petr Sgall (eds.): *Prague linguistic circle papers, vol. 1* (Philadelphia, 1995), 261–294, 267.

7. Sometimes, of course, unusual occurrences can provide unforeseen possibilities for textual preservation. The most famous example of this is the large number of Greek papyri that have been recovered from the ruins of Herculaneum, covered by volcanic material in the eruption of Mount Vesuvius in AD 79.

8. The point of the durability clay tablets as opposed to material written on perishable material is also made (in reference to ancient Aramaic as opposed to cuneiform languages) in Stephen Kaufman: "Aramaic" in Robert Hetzron (ed.): *The Semitic languages* (London 1997), 114–130, 115.

9. A good example of this can be found in what is certainly one of the most widely used modern introductions to the Akkadian language and its writing system, John Huehnergard: *A grammar of Akkadian* (Winona Lake, 2011 [1997]). In this very thorough textbook, many of the exercise texts come from Old Babylonian "use texts" such as private letters, contracts etc. To be sure, the end of the book includes a tablet from the Old Babylonian version of the *Epic of Gilgamesh*, but the focus on everyday texts well underscores the large amount of this type of material that has been preserved from cuneiform cultures. There are, of course, other textbooks which center more squarely on literary texts, but Huehnergard's volume is a good example of how the textual situation in cuneiform languages is reflected even in literature for the beginner's level.

10. As an example of this type of textual material from cuneiform-using Mesopotamia, I would like refer to Simo Parpola (ed.): *Letters from Assyrian and Babylonian scholars* (Helsinki, 1993).

11. Original text according to J.A Black, G. Cunningham, J. Ebeling, E. Flückiger-Hawker, E. Robson, J. Taylor & G. Zólyomi: *The electronic text corpus of Sumerian literature* (etcsl.orinst.ox.ac.uk) (Oxford, 1998–2006): text Shulgi B, lines 358–365 (Accessed latest August 1, 2015). The translation is mine, inspired by the translation of the ETCSL.

12. On the cultural and temporal background of the Afro-Asiatic family (sometimes called "Hamito-Semitic"), see e.g. Christopher Ehret: "Language and history" in Bernd Heine & Derek Nurse (eds.): *African languages. An introduction* (Cambridge, 2000), 272–297, esp. 290–293. There are, it should be noted, other suggestions for the date of Proto-Afro-Asiatic unity as well. The large Afro-Asiatic etymological dictionary of Orel and Stolbova settle for a date "no later than 10,000–9,000 BCE", a date also consistent with the above time-frame, though basing itself on glottochronological data, a method towards which many historical philologists, myself included, feel a great deal of scepticism (Vladimir E. Orel & Olga V. Stolbova: *Hamito-Semitic etymological dictionary. Materials for a reconstruction* [Leiden/New York/Köln, 1995], ix).

13. Most famously proposed in Colin Renfrew: *Archaeology and language. The puzzle of Indo-European origins* (London, 1987). He later published a somewhat revised version of his hypothesis in Colin Renfew: "Time depth, convergence theory, and innovation in Proto-Indo-European. 'Old Europe' as a PIE linguistic area" in *Journal of Indo-European Studies* 27 (1999), 257–293. In that article, Renfrew views the proposed Anatolian homeland as being valid only for an Indo-European unity preceding an alleged split between the Anatolian sub-family (which would subsequently include languages such as Hittite and Luwian) and the rest of Indo-European, which would have its origin in "Old Europe", especially the Balkans.

14. The Eurasian steppes theory has been argued well in James P. Mallory: *In search of the Indo-Europeans. Language, archaeology and myth* (London, 1989) and later (and in greater archaeological detail) in David W. Anthony: *The horse, the wheel, and language. How Bronze Age riders from the Eurasian steppes shaped the modern world* (Princeton, 2007). Recently, genetic studies have pointed in this direction as well: see Wolfgang Haak, Iosef Lazaridis, Nick Patterson *et al.*: "Massive migration from the steppe was a source for Indo-European languages in Europe" in *Nature* 522 (2015), 207–211.

15. For the reconstructed forms, I refer to the available introductions to comparative Indo-European linguistics, for example Benjamin Fortson: *Indo-European language and*

culture. An introduction (2nd ed.) (Chichester, 2010 [Oxford, 2004]). Fortson discusses the "I am" word on p. 96 and the "sun" word on p. 123, albeit with a slightly different orthography than I have used above.

16. Using this illustrative example was suggested to me by one of the anonymous peer-reviewers, for which I would like to thank him/her.

17. The Anglo-Saxon text follows the edition in D.N. Dumville, Susan Irvine & Simon Keynes: *The Anglo-Saxon chronicle. A collaborative edition*, vol. 7 (Cambridge, 2004). A translation of the relevant passage (which has inspired my own translation above in certain respects) can easily be found at www.britannia.com/history/docs/1087.html (accessed latest July 31, 2015).

18. The point of how much English has changed during its relatively short time of attestation has of course been made by others; one popularly aimed example is Rachel Kaufman: "Ray cats, artificial moons and the atomic priesthood. How the government plans to protect our nuclear waste" (mentalfloss.com/article/27476/ray-cats-artificial-moons-and-atomic-priesthood-how-government-plans-protect-our, accessed latest July 31, 2015).

19. I have put forth these arguments concerning the conservative effects of standardized writing systems and their inhibiting of the expression of newly created inflectional forms earlier, in popular form, in Ola Wikander: *I döda språks sällskap. En bok om väldigt gamla språk* (Stockholm, 2006), 113–114. There, too, I use the example of the Coptic verbal inflection.

20. For a modern introduction to what can be reasonably said about the ancient Etruscan language, see R.E. Wallace: *Zikh rasna. A manual of the Etruscan language and inscriptions* (Ann Arbor, 2008), which also includes an overview of known vocabulary and textual genres.

21. Edward Ullendorff: "Is Biblical Hebrew a language" in *Bulletin of the school of Oriental and African Studies* 34 (1971), 241–255.

22. The film (dealing with the Finnish nuclear waste depository, specifically) addresses a number of the questions that are at the center of this article; I recommend it for viewing.