AN ASTRONOMICAL OPACITY EFFECT*

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This note presents an analogy for the linguistic construct 'comparative markedness' as it might account for an apparent opacity effect associated with the presence/absence of helium in the universe.

1. Introduction

It is often instructive to invoke real-world phenomena as analogies for essential (but possibly esoteric) linguistic constructs. A valuable optimality theoretic construct that may be amenable to an analogy is 'comparative markedness' (McCarthy 2002, 2003), which was put forward to account for certain widely observed phonological opacity effects (i.e., generalizations that are not surface-true). The theoretical innovation of McCarthy's proposal is that markedness violations can be partitioned into two nonoverlapping sets. One set of violations is assigned by a comparative markedness constraint that is sensitive to marked structures that are shared with the fully faithful candidate. Those violations are considered 'old' in the sense that they came without modification directly from the input. The other set of violations is considered 'new' and is assigned by a different comparative markedness constraint that is sensitive to the same marked structures, except that those marked properties are derived from sources other than the input. This means that some phonological processes might derive marked structures that will either need to be preserved or banned, independent of 'old' marked structures. By splitting markedness constraints into old-markedness ($_{O}$M) and new-markedness ($_{N}$M) with an intervening faithfulness constraint, comparative markedness is able to account for those opaque generalizations that have come to be known as counterfeeding chain shifts and grandfather effects. The non-surface-true character of these generalizations can be illustrated by a commonly occurring chain shift in young children's developing phonologies (e.g., Dinnsen and Barlow 1998). More specifically, one process bans relatively marked interdental fricatives from the child's inventory, replacing them with labiodental fricatives (e.g., 'thumb' realized as [fʌm]). Another interacting process contradicts the ban on interdentals by forcing grooved coronal fricatives to be realized as interdentals (e.g., 'sun' realized as [θʌn]). This prohibition against target interdentals, on the one hand, and the preference for derived interdentals, on the other, is reconciled within comparative markedness by splitting the markedness constraint that bans interdentals (*θ) into its two comparative mark-

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edness counterparts, $_{O}$*θ and $_{N}$*θ, with the relevant faithfulness constraint ranked between them as follows: $_{O}$*θ >> FAITH >> $_{N}$*θ. Comparative markedness is, thus, able to take advantage of the different sources (i.e., underlying versus derived) for marked interdentals in its explanation for the asymmetry in their behavior. While old (underlying) interdentals are absolutely banned from occurring, new (derived) interdentals are retained because of the higher ranked faithfulness constraint that demands that coronal place be preserved.[1]

Opaque generalizations of this sort are common in both developing and fully developed languages, but one might wonder whether there are other real-world (nonlinguistic) phenomena that behave in the same way and are amenable to an account in comparative markedness terms.

2. The analogy

For the analogy, we turn to the realm of astronomy and an apparent anomaly in the presence/absence of helium in the universe. One of the most abundant elements of the universe is helium, second only to hydrogen. Interestingly, however, this lightweight gas is rare on Earth. Other large planets in our solar system (e.g., Jupiter and Saturn) and the sun and stars contain large quantities of helium. Most of the helium that is present in the universe is from the Big Bang. The helium that might have been present in the origins of the Earth's atmosphere escaped into space due to Earth's weak gravitational forces. The little helium that does occur on Earth is derived from the radioactive decay of heavy metals (uranium) and must be extracted from natural gases that are trapped below the Earth's surface. The important point is that helium has two sources, and the helium that does occur on Earth comes from only one of those sources.

The astronomical opacity effect that we are depicting here is that, while helium is banned from Earth's atmosphere, it is permitted to occur if derived from some source other than the Big Bang. In comparative markedness terms, the absence of Big Bang helium in Earth's atmosphere could be attributed to the dominance of a comparative markedness constraint banning old helium ($_{O}$*HELIUM) over a generalized faithfulness constraint (FAITH), which preserves helium. That faithfulness constraint can be thought of as being grounded in gravitational forces and/or the trapping effect of the Earth's crust. The retention of new helium derived from radioactive decay of heavy metals can then be attributed to the dominance of FAITH over the comparative markedness constraint that bans new helium ($_{N}$*HELIUM). The different sources for helium can thus result in the different behavior of helium on Earth. The constraint hierarchy for Earth ($_{O}$*HELIUM >> FAITH >> $_{N}$*HELIUM) corresponds with the comparative markedness schema for chain shifts in developing and fully developed languages ($_{O}$*θ >> FAITH >> $_{N}$*θ). The presence of both old and new helium on larger planets, such as Jupiter, illustrates another instance of the typology predicted by comparative markedness, namely the transparent surface-true generalization that helium from any source is retained (FAITH >> $_{O}$*HELIUM, $_{N}$*HELIUM).

As we all know, most analogies begin to fall apart when pushed. This analogy may be no different in light of the other typological predictions of comparative markedness. That is, comparative markedness constraints are presumed to be freely permutable in their rankings. Consequently, if we were to extend comparative markedness further into astronomy, a

[1] This assumes, of course, that grooved coronal fricatives are also banned by an undominated constraint.

prediction would be that there could be an extraterrestrial body that retained helium from the Big Bang but that had no derived helium ($_{N}$*HELIUM >> FAITH >> $_{O}$*HELIUM). This would represent the other type of non-surface true opacity known as a grandfather effect, but it seems unlikely that such a situation could occur because all planets, moons, stars and asteroids are assumed to contain heavy metals that produce helium from radioactive decay. For the same reason, then, the other typological prediction of comparative markedness (i.e., that there could be an extraterrestrial body with no helium from any source) also seems unlikely to be supported ($_{O}$*HELIUM, $_{N}$*HELIUM >> FAITH). This latter prediction would represent the fully transparent (but likely false) generalization that helium is absolutely banned from some extraterrestrial body. The limitation of this analogy seems to reside in the nonpermutable character of the putative comparative markedness constraints relating to helium. However, if new derived helium were to vent into Earth's atmosphere, it would then behave like old helium—escaping into space. There thus appears to be an implicational relationship such that the presence of old helium entails the presence of new helium, but not vice versa. While this analogy admittedly has some shortcomings, it does at least illustrate some of the workings and predictions of comparative markedness.

References

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