Deafness & anguage

By **Yara Al-nouri**

According the World Federation of the Deaf, deafness - or auditory deprivation - is the third most common physical condition following arthritis and heart disease; as such, it presents an interesting case for studying human communication. As defined by the Oxford Medical Dictionary, deafness refers to total or partial hearing loss in one or both ears (2016). While deafness can be acquired through injury or trauma to the inner ear or through old age , it can also be a congenital condition. In the United States alone, an estimated two to three children out of every one thousand are born with profound hearing loss in one or both ears every year (Hearing Loss Association of America). For those born with hearing loss and those who lose their hearing before they learn to speak, their deafness could be categorized as prelingual deafness. Prelingual deafness poses a challenge for language and speech acquisition, given that auditory input is necessary for the development of both processes. Further, as Andrew Solomon writes, "the issue of deafness in most societies is one of linguistic exclusion" (2012:83). Deafness can be isolating for many because there is not so much a physical barrier between them and their social world, but an invisible one wherein communication is effectively cut off.

However, this is not to say that deaf individuals do not have any language ability. In fact, many deaf people learn to speak orally or use alternative forms of communication, such as American Sign Language (ASL). Additionally, the development of technologies, specifically cochlear implants, also simulate the experience of hearing for individuals with hearing loss; therefore enabling them to more effectively communicate with the hearing world. However, the debate surrounding cochlear implants is not so much about their efficacy, but rather the ethics of the implant. In this paper, I articulate the debates surrounding cochlear implants, and then move forward to an examination of the neuroscience underlying language acquisition for prelingually deaf individuals.

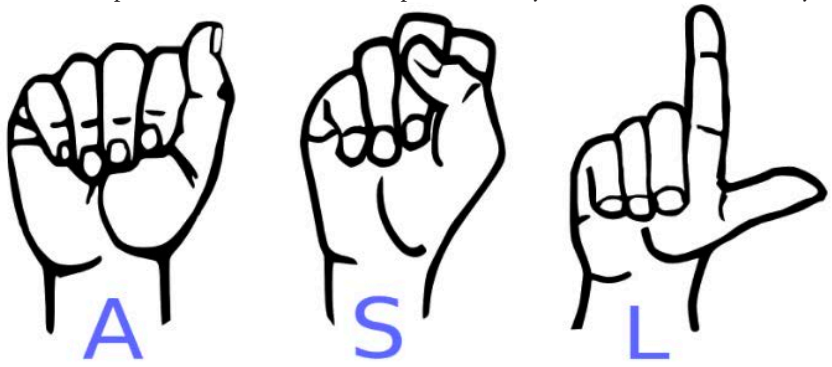
Big "D" versus Little "d"

In examining deafness as a topic, it is necessary to include a discussion about the debate between Deafness as a culture and deafness as a disability. The capitalization of "Deafness" refers to culture whereas the lowercase "deafness" indicates the pathological condition or impairment (Solomon 2012:50). While those in the medical sciences see deafness as a disability, there are many in the Deaf community who oppose this notion, opting instead to celebrate their difference as a cultural minority.

In fact, those who identify with Deafness as a cultural identity define their lived experiences as being enhanced by "Deaf gain", rather than being tarnished by hearing loss (Bauman and Murray 2010). As a concept, Deaf gain shifts the narrative of deafness from one of impairment and loss to a narrative of embracing and celebrating the benefits of being Deaf (Bauman and Murray 2010).

Part and parcel of Deaf gain and the Deaf community is the use of American Sign Language, or ASL, as a primary means of communication (see Figure 1). ASL is a type of language which utilizes physical gestures, as articulated through the hands, face, and body, to communicate (National Institute on Deafness and Other Communication Disorders). As such, it is a highly visual language; indicating that sensory information for the deaf is usually obtained through vision (Lane and Bahan 1998:298). It is a distinct language from English as it has its own grammar rules. For an estimated half million Americans, ASL is their primary language. Moreover, cultural and artistic endeavors have been created using ASL. In other words, ASL provides people in the Deaf world a sense of connection, community, and identity (Lane and Bahan 1998:297). Additionally, those in the Deaf community tend to condemn the use of cochlear implants as they see the device as a threat to their culture (Solomon 2012). In fact, some members of the Deaf community are so averse to cochlear implants that they argue that the implants are a form of "genocide" against the Deaf (Sparrow 2005:135). More specifically, cochlear implants represent a threat to the linguistic component of Deaf culture as cochlear implants are intended to boost spoken communication while discouraging the use of ASL (Ringo 2013).

Figure 1 Visual representation of ASL. "ASL spelled out" by Psihedelisto is licensed by CC0.



While the Deaf community exists, this does not mean that all deaf individuals choose to identify with the Deaf group. Many deaf individuals choose to identify as individuals with disabilities, and use English as their primary form of language (Lane and Bahan 1998:298). Additionally, many of those who identify with Deafness as culture are Deaf of Deaf, or Deaf children born to Deaf parents, meaning that they are often brought up within the Deaf community (Mitchell and Karchmer 2004). However, there are also deaf children born to hearing parents. According to the National Institute on Deafness and Other Communication Disorders, more than 90 percent of deaf children are born to hearing parents in the United States (2016). A large number of these deaf children learn to use spoken English through speech therapy and cochlear implants.

The commonalities between the two camps, however, extend beyond the condition of hearing loss. Because the society and world we live in is made for those who can hear, those who cannot hear will always "be at a disadvantage." As Andrew Solomon phrases it, the question moving forward is "whether people prefer to be marginal in a mainstream world, or mainstream in a marginal world, and many people quite understandably prefer the latter" (2012:107). In other words, those who "prefer to be marginal in a mainstream world" refers to those who see their deafness as a disability, and those who "prefer to be mainstream in a marginal world" refers to those who see Deafness as a culture. Yet the two are not mutually exclusive, and seeing your deafness as a disability does not necessarily encompass a sense of self-loathing. Solomon invites us to think more empathically about the ways that we interact with difference, to think deeply about the ways that we construct our society, and to ask ourselves: how welcoming is our world to the other?

A Brief History of America's Treatment of Deaf People

To understand the resistance of the Deaf community to advocate for and accept cochlear implants, we must first look at the history of marginalization of the deaf. Throughout history, and we see evidence of this even in Aristotle's writing, the perception of deaf people has always been derogatory; as assumptions about deafness, because of silence, were always associated with assumptions of stupidity (Solomon 2012:51)(Padden 2005:509). As such, one reason why the Deaf community so vehemently defends ASL is because ASL symbolizes a sort of liberation as it gives them a voice to be heard (Padden 2005: 509).

There is a history of the segregation and exclusion of deaf people from society. For instance, throughout American history, in every state, deaf children were institutionalized (Padden 2005: 508). While the late 1970s brought along a decrease in institutionalization as deaf children were integrated with hearing children in education, deaf people still face certain forms of discrimination and oppression to this day. One of the most revolutionary moments in American history is the creation of educational and academic institutions specifically for the deaf and hard of hearing. The first American school for the Deaf was founded in 1817. Springing from it was the continued proliferation of these types of Deaf schools throughout the nation, lasting until 1953 when the last deaf school was built (Padden 2005:509). These deaf schools segregated deaf children from hearing children, acting like boarding schools. They also influenced the demographics and locations of deaf communities in the United States, by reorganizing deaf people into certain geographies based on the location of deaf schools. While these schools separated deaf children from other children, they also brought together individuals who felt extremely isolated because of their deafness (Padden 2005:510). Deaf children were also able to learn sign language at these schools, which is of particular importance for those born to hearing parents (Padden 2005:511).

Advancements in modern technology, including cochlear implants, such as cell phones and digital means of communication have opened up the social worlds of the deaf and hard of hearing, decreasing the communicative divide between the two.

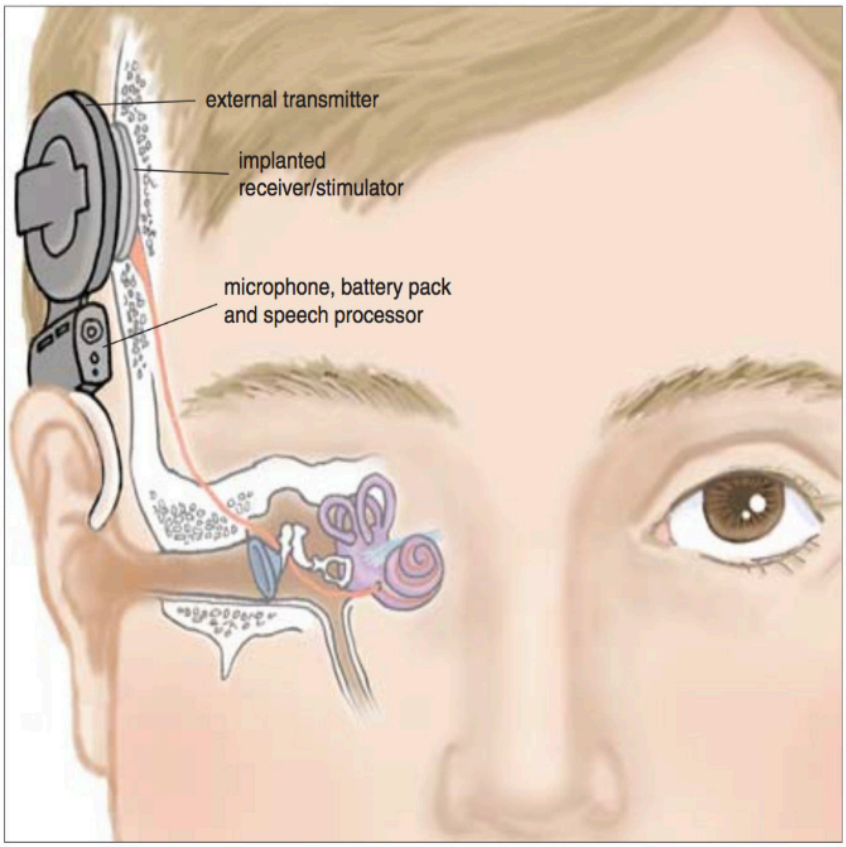


Figure 2 Visual Depiction of Cochlear Implant Mechanics. Taken from: Dorman, M.F. & Wilson, B.S. (2004). The Design and Function of Cochlear Implants. *American Scientist, 92,* 436-445.

Cochlear Implants

Cochlear implants are neural prosthetics that use electrodes to electrically stimulate the cochlea or inner ear: in turn providing the recipient with functional hearing or sound perception. The device is surgically implanted. The implant consists of external (i.e a microphone, speech processor, and transmitter) and internal (i.e. a receiver and electrodes) components

(see Figure 2). The internal and external components of the cochlear implant are able to communicate via radio frequencies. A microphone picks up sound signals from the external environment, sending them to the speech processor and transmitter, where these sound signals will then move to the receiver-stimulator, where they will be converted by the electrodes implanted at various points throughout the cochlea. Electrodes are placed at different points along the cochlea to code for different sound frequencies and produce a percept or stimuli that matches the location of the electrode; in other words, electrodes work by frequency-to-place representation. Because speech has many different frequencies, it is necessary to place the electrodes throughout the cochlea to electrically code speech. The more electrodes, and subsequently, the more channels, the closer the cochlear implant is able to get to detecting normal speech. The electrodes, then, electrically stimulate the auditory nerve endings, which send the information to the brain where it is then processed (Dorman and Wilson 2004)(Namasivayam 2004) (Macherey and Carlyon).

The first attempt at developing a neural prosthetic that would mimic audition was in 1957 in Paris, France, and ultimately, failed. In 1961, an American otologist, William House attempted to recreate the device, deciding to improve on the failures of the last attempt by stimulating five different points along the cochlea, as a way to make the implant more

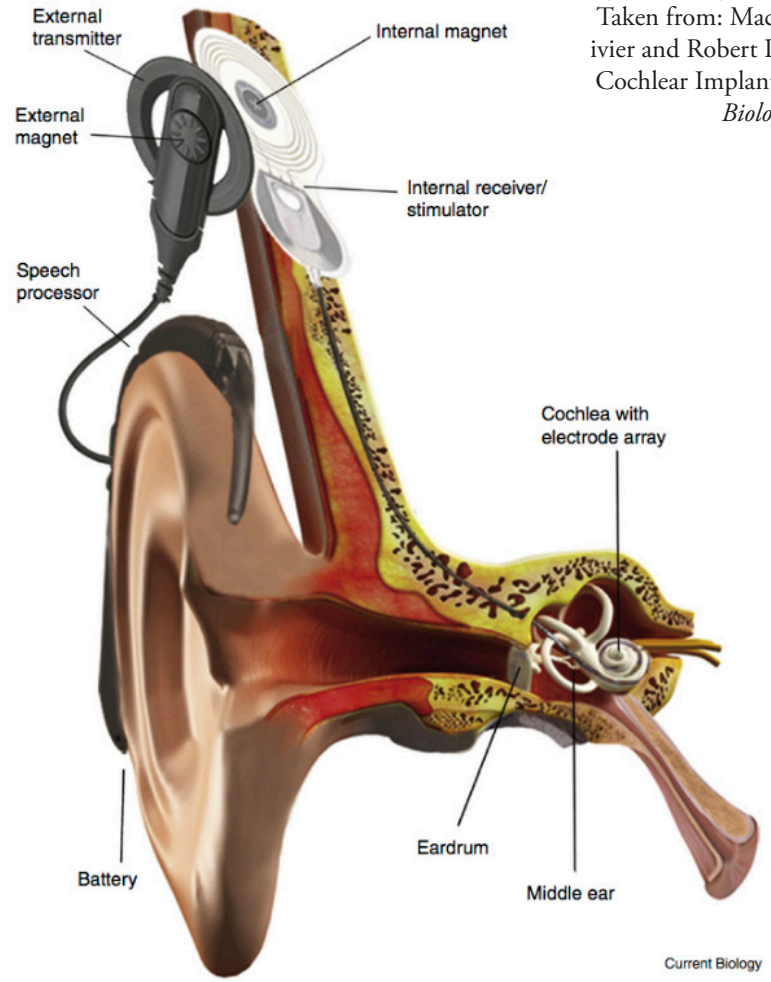


Figure 3 Diagram of the ear. Taken from: Macherey, Olivier and Robert P. Carlyon. Cochlear Implants. *Current Biology 24 (18)*

sensitive to different frequencies of speech. Again, this attempt failed (Blume 1999:1258). However, the 1970s brought along advancements in medical technology, allowing House and his cohorts to develop a more successful model of the device. As the technology of the implant improved, so did its global, professional recognition in the 1980s. The FDA approved the device in 1984, and six years after that, the FDA moved to approve minors for the implant in 1990 (Blume 1999:1258).

Given that cochlear implants essentially require an individual to learn how to hear with the device and that there is a critical period for language acquisition, it is typically recommended that prelingually deaf children receive the implant as early as possible. However, there is an ethical dilemma surrounding the surgical implantation of cochlear implants in children. There are three primary ethical debates about the issue. The first concerns the fact that children are unable to give informed consent, and that medical practitioners do not take into account the possible psychological and social effects of the surgery on children. The second concerns the culture clash between the Deaf community and the hearing world as they have different values regarding cochlear implants. The

third debate argues that policies that allow children to be implanted impedes on the rights of the Deaf community, and is an attempt to rid the world of deaf people (Lane and Bahan 1998).

Neurological Basis of Hearing

As a mechanical process, hearing requires the conversion of sound waves into neural impulses. As the sound waves move from the air, they are funneled into the eardrum or tympanic membrane by the outer ear. The sound waves then cause a vibration of the tympanic membrane, moving through the tiny bones of middle ear or ossicles. From the ossicles, the sound waves cause the movement of fluids contained inside the cochlea, bending the stereocilia and tiny hair cells lining the basilar membrane. It is at this point where the physical sound waves are converted into neural impulses as the auditory nerve is stimulated. Ultimately this auditory information lands itself in the auditory cortex, located in the temporal lobe.

Neurological Basis of Language

The traditional neurological bases for language are considered to be Broca's area, Wernicke's area, and the arcuate fasciculus which serves as a bridge between Broca's area and Wernicke's area (Fujii et al. 2016). Wernicke's area is responsible for language comprehension whereas Broca's area is responsible for speech production; both areas are located in the cerebral cortex. Language is processed through both the dorsal and ventral streams (Fujii et al. 2016). Additionally, spoken language is usually lateralized to the left hemisphere.

Deafness and Neuroscience

As acknowledge by Olulade et al., most extant neuroscience research on deafness has been conducted primarily on deaf individuals who are native signers, despite the fact that this sample is not representative of actual deaf populations. In fact, approximately 95% of deaf Americans use English as their primary language, and as such, it is necessary to turn researchers towards sampling methods that accurately reflect the deaf population (Olulade et al. 2014: 5613).

Much like spoken language, deaf native signers also exhibit lateralization of language processes to the left hemisphere as indicated by studies on unilateral stroke patients. Some studies, however, have shown that deaf native signers of ASL also exhibit activity in their right hemisphere (Campbell et al. 2007). These findings suggest that language processing "is not determined by the auditory input modality" (Campbell et al. 2007:5). In regards to specifically sign language production, studies have been able to corroborate that sign production is very much lateralized to the left hemisphere. Further, neuroimaging studies have consistently shown that left inferior frontal region activation for the production of sign language, and that Broca's area is consistently utilized in this process of sign production (Campbell et al 2007:13). Given this, we can infer that the production of sign language is similar to that of spoken language.

While prelingual deafness has potential for altering the development of some neurological processes of language, that does not exclude them the possibility of language acquisition nor necessarily mean that they will be hindered by their deafness.

Conclusion

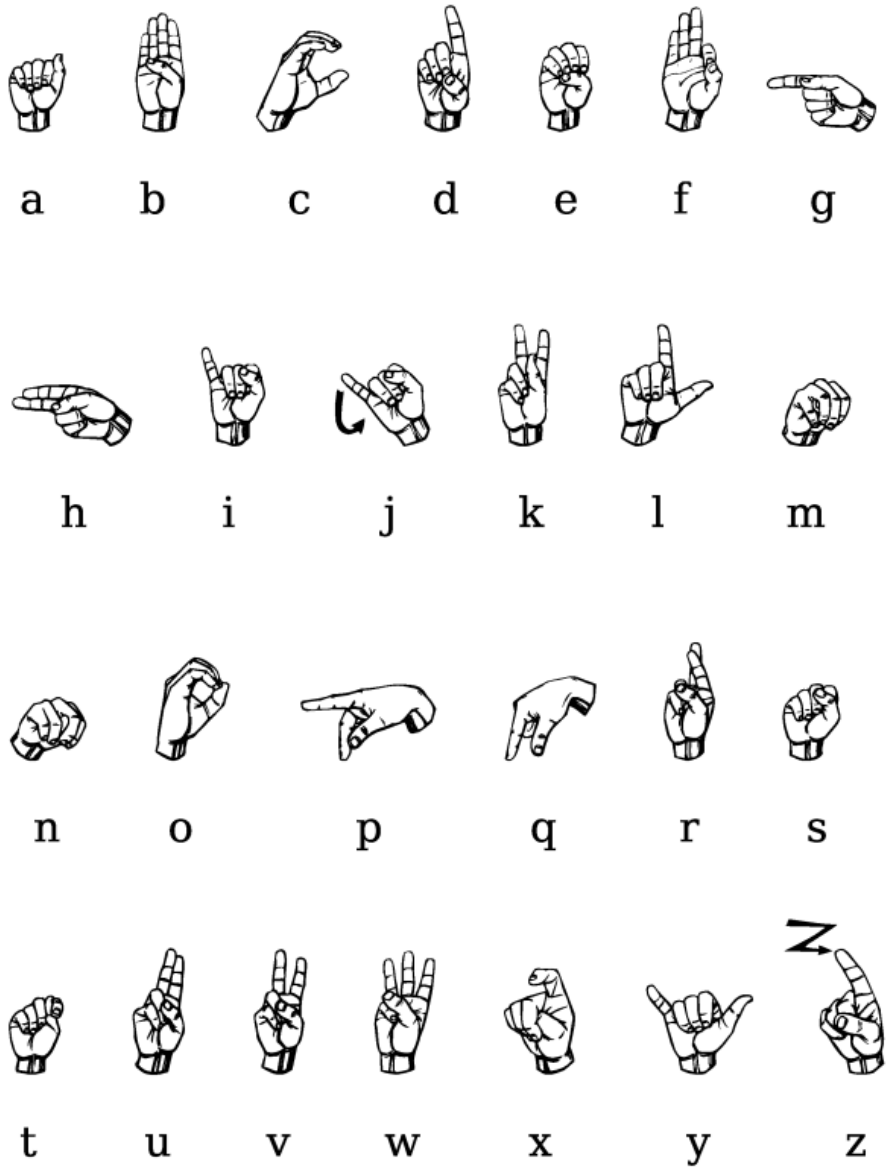
In conclusion, the neuroscientific study of deafness is relevant to society because it has larger implications for the ways in which we think about disability, and the quality of life for deaf individuals. However, the neuroscientific study of deafness is enhanced by thinking about the nuances underlying deaf identities and Deaf culture. While neuroscience contributes necessary knowledge about the science of deafness, it can often tend towards a conception of deafness as a negative life experience. Deaf culture invites us to celebrate difference, and re-conceptualize what "normal" means when we think about the body and ability.

References

Al-nouri, Yara and Mia Fox. 2017. "The Dialectics of Defining Deafness: Deconstructing the Divide."
Bauman, H-Dirksen L. and Joseph J. Murray. 2010. "Deaf Studies in the 21st Century:
'Deaf-gain' and the Future of Human Diversity." The Oxford Handbook of Deaf Studies, Language and Education.
Blume, Stuart S. 1999. "Histories of cochlear implantation." Social Science and Medicine 49:12571268
Campbell, Ruth, Mairead MacSweeny,

and Dafydd Waters. 2007. “Sign Language and the Brain: A Review.”
Cochlear Implants. 2017. Retrieved September 13, 2017 from http://www.asha.org/public/hearing/Cochlear-Implant/
Dorman, M.F. & Wilson, B.S. 2004. The Design and Function of Cochlear Implants. American Scientist, 92, 436-445.
Fujii, Masazumi, Satoshi Maesawa, Sumio Ishiai, Kenichiro Iwami, Miyako Futamura, and Kiyoshi Saito. 2016. “Neural Basis of Language: An Overview of An Evolving Model.” Neurol Med Chir (Tokoyo) 56: 379-386.
Lane, Harlan and Benjamin Bahan. 1998. “Ethics of cochlear implantation in young children: A review and reply from a Deaf-World perspective.” Otolaryngology - Head and Neck Surgery. 119(4): 297- 313.
Kral, Andrej, Arthur N. Popper, and Richard R. Fay. 2013. Deafness. New York: Springer.
Ringo, Allegra. 2013. “Understanding Deafness: Not Everyone Wants to Be ‘Fixed’”’ Retrieved Apr. 3, 2017 (http://www.hearingloss.org/content/basic-facts-about-hearing-loss).
Sparrow, Robert. “Defending Deaf Culture: The Case of Cochlear Implants.” The Journal of Political Philosophy. 13(2): 135-152.
Solomon, Andrew. 2012. Far From the Tree: Parents, Children and the Search for Identity. New York: Scribner.
Hearing Loss Association of America. 2017. “Basic Facts About Hearing Loss.” Retrieved Apr. 19, 2017 (http://www.hearingloss.org/content/basic-facts-about-hearing-loss).
Macherey, Olivier and Robert P. Carlyon. Cochlear Implants. Current Biology 24 (18)
Martin, Elizabeth. 2016. “Deafness.” Concise Medical Dictionary. Oxford University Press.
Mitchell, Ross E. and Michaela Karchmer. 2004. “Chasing the Mythical Ten Percent Parental Hearing Status of Deaf and Hard of Hearing Students in the United States.” Sign Language Studies. 4(2): 138 -163.
Namasivayam, Aravind. 2004. Cochlear Implant Technical Issues: Electrodes, Channels, Stimulation Modes and more. Audiology Online.
National Institute on Deafness and Other Communication Disorders. 2017. “American Sign Language.” https://www.nidcd.nih.gov/health/american-sign-language
National Institute on Deafness and Other Communication Disorders. 2016. “Quick Statistics About Hearing.” https://www.nidcd.nih.gov/health/statistics/quick-statistics-hearing.
Olulade, O., Koo, D.K., LaSasso, C.J., and Eden, G.F. (2014). “Neuroanatomical Profiles of Deafness in the Context of Native Language Experience.” The Journal of Neuroscience 34(16): 5613-5620.
Padden, Carol A. 2005. “Talking Culture: Deaf People and Disability Studies.” PMLA 120(2):508-512.
World Deaf Federation. 2016. “Sign Language.” Retrieved Apr. 19, 2017 (https://wfdeaf.org/human-rights/crpd/sign-language/).

Title Image: Pixabay. 2012. https://pixabay.com/en/language-sign-hand-speech-letter-40443/



“American Sign Language Alphabet” laid out by Darren Stone is licensed by Public Domain.