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New Idea

Possible evolution of teleological bias, language acquisition, and search for meaning from primitive agency detection

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Abstract

The perception component of the language faculty and the teleological notion that everything may have intentions and purpose could have developed from primitive agency detection seen in most moving animals. Many new-born, totally naive animals show predator avoidance and behave as if everything around may be alive and dangerous and have malevolent intentions. Piaget demonstrated that young children believe that everything around is probably alive and has purpose and intentions. The perception component of the language faculty involves an intrinsic motivation to search for intentions and meanings of sound combinations (words and phrases), and a search for the meanings and intentions of systematic changes in words, that is a search for the grammar rules. Possible homologs to animal genes for predator avoidance or perception of calls could be compared in humans and chimpanzees. Evidence of positive selection or accelerated evolution of human homolog genes might indicate putative genes for language perception.

Keywords: language faculty, language perception, teleology, predator avoidance, intrinsic motivation, hyperactive agency detection.

Teleological Bias

People tend to assume that things exist for a purpose. This teleological way of thinking was central to the early philosophy of Plato and Aristotle; it was discussed by Kant and is a basic aspect in the work of Hegel (Wattles 2006). The teleological approach is observable very early in life, when young children first ask "what's that?", then ask "what's it for?" and "why?" (Callanan and Oakes 1992, Kelemen 1999, Gergely and Csibra 2003, Kelemen et al. 2005), apparently assuming that there are answers to these questions. Teleology, magical thinking, animism, and "artificiality" of children were extensively investigated by Piaget (1929). Animism is that everything is animated and has intentions and purposes. "Artificiality" is the notion that things are made by somebody for a purpose. Piaget's technique of systematically asking children at different ages all sorts of "naïve" questions (where does the sun come from?) revealed that even very young children have extensive notions of the workings of the world. The sun is for shining and keeping you warm, the rain is for watering the grass, and giraffes have long necks so they can reach the leaves in the top of the trees.

Very young children believe everything is alive and has intentions. The beliefs are modified as the child acquires more knowledge. Older children believe that only moving things are alive. Still older children, say 7–12 years of age, believe that only things that move by themselves (including rivers) are alive (Piaget 1929). There has been much discussion about the timing, character, and causes of the stages (Sutherland, 1992) in the changing mental representations, but the basic notions stand, and they are confirmed by contemporary psychologists. Carey (1985) has investigated the changes in concepts, and Kelemen's group has investigated the teleological biases in the thinking of children and adults (Carey 1985, Kelemen 1999, 2004, Inagaki and Hatano 2006, Rosset 2008, Kelemen and

Rosset, 2009, Kelemen et al. 2013). Adults also often behave as if things are alive and have intentions, although they know quite well that this is not the case (Rosset 2008, Kelemen and Rosse 2009). Many people scold their cars when they will not start on frosty mornings, talk to their computers when they "misbehave", and order their ball to avoid the trees and bunkers on the golf course. Even natural scientists who should know better often use teleological reasoning, especially in situations when pressed for time (Kelemen et al. 2013).

In the physical and natural sciences, teleological explanation is not accepted, as an effect cannot come before its cause. In much of biology, teleological explanations are frowned upon (Perlman 2004). However, in feedback regulation in cybernetics (Rosenblueth et al. 1943), cause and effect are thoroughly entwined and a set point or "goal" needs to be established. Living organisms are complicated self-regulating feedback systems shaped and pruned by natural selection over thousands of generations. They often behave as if they have purpose, *qua* the "memory" inscribed in their DNA of what works and what does not work. When planning experiments, it is a useful shortcut to ask: what is the purpose of this organ, enzyme, or behavior?

Language Acquisition

The ability of children to effortlessly and automatically learn to understand and speak their mother tongue has been called the language acquisition device (Chomsky 1965), the language faculty (Hauser et al. 2002), or even the language instinct (Pinker 1994). The language faculty begins with language perception or input: the ability to infer what unknown words mean and the ability to remember them after one or very few presentations—so-called fast mapping (Carey and Bartlett 1978, Bloom 2000, Carey 2010). It also includes what the slightest changes in words or word order mean-—that is, the meanings of grammar and syntax. However, most work has been done on the production or output components of the language faculty (Chomsky 1965, Karmiloff and Karmiloff-Smith 2001, Hauser et al. 2002, Clark 2003) as they are much easier to measure.

The following is a very brief non-technical sketch of some of the input or perception components of the language faculty (Karmiloff and Karmiloff-Smith 2001, Clark 2003). The input part of the language faculty encompasses at least three components: motivation, word understanding and retention, and grammar acquisition. The first is the automatic, intrinsic motivation to acquire language. The second is the ability to tease out the meanings of sound combinations and remember them. The third is the ability to understand and retain the changes in meaning caused by systematic changes in words.

Search for Meaning

First, young children are intrinsically motivated to acquire language. Motivation is what moves people to do things, be it unconsciously, consciously, intrinsically or extrinsically. The motivation for acquiring language is intimately linked to the desire for interaction and communication with members of the group (Mowrer 1950, 1980, Bloom 1993, Dunbar 1996, 2004, Fitch 2010). There is no point in language if there is nobody to talk to.

Animals are not motivated for acquiring language, but some social group-living species can be taught language components. Bonobos or dwarf chimpanzees (Savage-Rumbaugh et al. 1986, 1998), chimpanzees (Terrace et al. 1979), dogs (Kaminski et al. 2004, Pilley and Reid 2011, Griebel and Oller 2012), and parrots (Pepperberg 2010) can learn names of things and actions, in fact several hundred of them. The major difference between children and the animals is that the animals need to be extrinsically motivated by dedicated training in rich social environments.

Children seem to assume that things and deeds have names and they search for the meanings (Pinker and Jackendoff 2004, Fisher and Marcus 2006, Gervain and Mehler 2010). The automatic search for meanings extends to the slightest of ways words may be changed or combined. When words are changed in any regular or systematic way, it is assumed that these changes convey meaning. The changes could be vocal change, different tones, word order, prefixes, infixes, suffixes, or whole batteries of these as in polysynthetic languages. A specific change may mean something happened in the past, another that something will happen in the future, and yet another represent a wish that something should happen. This search for meanings of changes in word order or word structure becomes the search for rules of morphology and syntax. If no grammatical rules are available, as in pidgin-speaking communities, children create them among themselves, and develop creole languages with grammar. This has been observed repeatedly, for example on Hawaii (Bickerton 1990) or in Papua New Guinea. The process of spontaneous grammar creation was followed in detail by language psychologists when deaf children in Nicaragua were brought together and collectively developed Nicaraguan sign language over about two decades (Goldin-Meadow and Mylander 1998, Senghas and Coppola 2000).

The effortless acquisition of new words—the fast mapping (Carey and Bartlett 1978, Carey 2010)—resembles the filial imprinting observable in newly hatched ducklings and chicken (Bolhuis and Honey

1998). Imprinting is characterized by immediate learning during a critical sensitive time period, which in ducklings is quite short, only a few days. Language acquisition also has critical sensitive time periods (Lenneberg 1967); they last for many years, but the sensitive periods of the input components are different. The intrinsic, unconscious motivation automatically to acquire a new language is strongest in childhood, and disappears in adulthood (Gardner and Lambert 1972, Crystal 1997). Young children acquire a second language without apparent effort, but it is quite difficult for adults to learn a second language, and they need to be consciously motivated to do so (Gardner and Lambert 1972, Dörniey 2001, 2009, Masgoret and Gardner 2003). The ability automatically to understand and remember new words in the mother tongue lasts into old age.

The default mental state for young children then seems to be: everything has meaning, intentions, or purpose, from the large scale workings of the sun, the rain, the wind, and to the smallest systematic differences in the ways words are changed. The children are intrinsically motivated to search for those meanings. This aspect is seldom mentioned in recent literature on language acquisition. For example the Cambridge Encyclopedia of Language (Crystal 1997) only has two entries on motivation: one on foreign language acquisition and one on a possible world language. Most people, laymen, linguists, and psychologists alike believe that humans are strongly motivated to learn to speak. Bickerton (1990) treats motivation as one of the prerequisites for protolanguage, and sometimes you find words like ”predisposition of children to interpret the noises made by others as meaningful signals” (Pinker and Jackendoff 2004), or ”the drive to acquire language is so robust” (Fisher and Marcus 2006), or ”the innate disposition for language acquisition” (Lenneberg 1967, Gervain and Mehler 2010). That babies want to learn to speak is so obvious and self evident that few people wonder. A non-speaking child is sent to the doctor to have its hearing or its head examined by everybody, language experts and lay people alike.

Motivation in language acquisition was treated by Skinner (1957) in his “Verbal Behavior” in terms of stimulus, operant conditioning and reinforcement. That may well be true of much learning, but it does not explain language learning specifically. For Lois Bloom (1993) the motivation for learning to speak is intentionality, the desire to express one’s thoughts and feelings to others. Fitch (2010) uses the term “Mitteilungsbedürfnis” about this piece of the language acquisition puzzle. Mowrer (1950, 1980) developed a theory of speech acquisition where social identification between child, parents and peers is an important motivating factor. Mowrer’s motivation theory was an important inspiration for Gardner and Lambert’s (1972) work on the importance of conscious motivation in second language learning. This is now an established field with a large body of literature (Dörnyei 2001, 2009, Masgoret and Gardner 2003).

Language Evolution

There are numerous theories on how language may have evolved (Chomsky 1965, Lenneberg 1967, Pinker and Bloom 1990, Nowak and Komarova 2001, Hauser et al. 2002, Christiansen and Kirby 2003, Fitch 2010, 2012, Tallerman and Gibson 2012). Pfenning et al. (2014) present an attempt at describing parallel gene transcription relating to vocal learning in humans and song-birds. According to Bickerton (1990, 1995, 2012) the language faculty developed in two stages: an early protolanguage with only vocabulary and no grammar, and a normal language complete with morphology and syntax, spoken in all known human societies. All children speak protolanguage below the age of two, at the one and two word stage (Bloom 1993, Karmiloff-Smith and Karmiloff 2001), and everybody speaks protolanguage when trying to communicate in an unknown foreign language (Bickerton 1990, 1995). Damage to Broca’s area in the brain also causes patients to speak only protolanguage (Bickerton, 1990, Ardila 2011). The usage-based language theory of Tomasello (2003) and the holistic theory of Wray (1998) fit quite well inside the protolanguage hypothesis.

Most work on the heritability of language has been on language production (Stromswold 2001). Several genes and chromosome regions that are important for language have now been identified. The best known is the dominant FOXP2 mutation (Fisher and Marcus 2006, Graham and Fisher 2013) found in the KE family after pedigree analysis of language impairment (Gopnik and Crago 1991). Several other candidate genes like CNTNAP2 and ROBO1 from dyslexia and language impairment were investigated in large cohorts by single nucleotide polymorphism, ‘SNP analysis’ (Bates et al. 2011, Graham and Fisher 2013). FOXP2 type genes are central for aspects of sound manipulation in other species, such as song in birds (Fischer and Scharff 2009) and echolocation in bats (Li et al. 2007), illustrating that a basal blueprint can be modified by evolution to suit different purposes. A FOXP gene is important for “self-learning” in Drosophila (Mendoza et al. 2014)

The FOXP2 language gene is an example of positive selection or accelerated evolution where 2 of 3 amino acid differences between the man and mouse gene products occurred between man and chimpanzee (Fisher and Marcus 2006). Accelerated evolution could also be gene duplication, especially if there is mutation in one of the pair, indicating a possible broadening in function. It could be production of species specific regulatory micro RNAs and many other possibilities (Somel et al. 2013).

Agency Detection

The search for meaning may have derived from a characteristic that most moving animals possess: agency detection or the ability to spot and react to a predator (Lima and Dill 1990, Barrett 2005, Herberholz and Marquart 2012). This is the instinct that causes bolting of horses, curling up of hedgehogs, and fear of the dark in children. Many newborn, totally naïve animals behave as if they "assume" everything around to be alive and dangerous, and have malevolent intentions. The agency detection module causes error management behavior: better safe than sorry, better bolt once too often than get eaten by the wolf (Haselton and Nettle 2006, McKay and Efferson 2010, Herberholz and Marquart 2012).

Much work done on agency detection or predator avoidance has been on the electrophysiology of escape, e.g. in crayfish and insects (Herberholz and Marquart 2012). There is also a huge literature in many species on testing for escape behavior and fear responses in the hope of finding animal models for depression and other psychiatric disorders, for example in mice (Blanchard et al. 2003, Cryan and Holmes 2005) and zebrafish (Kalueff et al. 2014).

A way to test the plausibility of the evolution of language acquisition from agency detection would be to find genes for predator avoidance or response to calls in animals, and examine corresponding genes in chimpanzee and humans for positive selection or accelerated evolution. This is of course a long shot, but some of the tests can be done right away by people with the relevant knowledge and access to the proper computer programs and databases. Other tests could require fairly crossing programs in salient species, but some such programs already exist (Jensen 2014).

Possible Experiments

In *Drosophila* there are two mechanisms for escaping a looming "danger". One mediates a headlong, reflex-like, uncoordinated jump into the air and is associated with the gene for the nicotinic acetylcholine receptor Dα7 (Fayyazuddin et al. 2006). The other mechanism was revealed when Dα7 was inactivated and has so far only been characterized electro-physiologically (Fotowat et al. 2009) as a much more deliberate escape fly-off. It would be interesting to know if the gene Dα7 is a counterpart of the nicotinic CHRNA7 genes in the human and the chimpanzee genomes, and to see if there is evidence of accelerated DNA evolution between man and ape. If that should be the case, the Dα7 gene would be a candidate for a language input gene. CHNRA7 is a suspect gene in schizophrenia, mental retardation, and epilepsy and CHRNA7 is duplicated in humans (Antonacci et al 2014). *Drosophila* can be investigated using the whole battery of classical and modern genetic methods (Bellen et al. 2010).

Analogs to language perception genes could perhaps be found in chicken (*Gallus gallus*). The domestic chicken has a repertoire of about twenty different calls, including separate alarm calls for aerial and ground predators, food calls, soft attraction calls, and territorial crowing (Collias 1987, Smith et al. 2011, Tefera 2012). Tefera (2012) even suspects that chicken may combine calls or in other words "speak primitive protolanguage". Layer breeds have been selected against broodiness and nesting behavior (Sharp, 2009). These behavior traits seem in a complex manner related to changes in genes for prolactin, prolactin receptors and dopamine receptors (Jiang et al 2005, Xu et al. 2010). Modern layer breeds seem to have lost the ability to respond normally to some calls (Tefera 2012). By examining crosses of layer breeds and wild type it might be possible to identify and locate genes for response to calls.

In some cases agency detection becomes perverted or turned upside down. That happens typically when an organism becomes infected by a parasite with host switching. In rats the normal predator avoidance is inverted by infection with *Toxoplasma gondii*, so that the animals become attracted by the smell of cat urine (Poulin 2010, Webster et al. 2012). An examination of which genes are turned on or off in infected rats might reveal possible agency detection genes.

Conclusion

It is the hypothesis of this paper that the teleological bias and the perception part of language acquisition have both evolved from agency/predator detection. Children behave as if there may be intentions, purpose and sense attached to any phenomenon, large as sun and rain, and minuscule like very small systematic changes in words, or (especially for deaf children) gestures and gesture combinations. The children search for the supposed meanings and acquire them after very few presentations. Some researchers suggest that a "hyperactive agency detection device" (HADD) is an important cause for the ubiquity of religion (Barrett 2000, Boyer 2003). I suggest that this HADD has evolved from general agency detection as a spandrel to the evolution of the perception component of language acquisition. Hence religion, the science quest, and the inevitability of conspiracy theories may all be different manifestations of the same general urge in young children to understand the intention and meaning of unknown new words. Elucidation of language acquisition may also lead to an understanding of those other characteristics of humans and human society.

Referees

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