Communication

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Communication is the transfer of information from a sender to a receiver where both the sender and the receiver map a signal to a particular meaning (see Hauser, 1996, for several other definitions). Although some may consider information transfer as anything that reduces the receiver's uncertainty about future events, such a definition implies that communication is a one-way system and does not take into account manipulation, or even the intentional ploy of the sender, in some cases to enhance the receiver's uncertainty about future events. If the signal to meaning mapping involves syntax (a formal structuring of the signals in relation to each other) this is termed **language**.

Signal to meaning mapping does not necessarily involve intention or conscious processing. Plants have also been found to communicate information with each other; for example undamaged sugar maple seedlings and corn synthesize compounds that make them less palatable – or even slightly toxic - when damaged, conspecifics emit airborne signals when their leaves are damaged, and chemical signals can even be emitted that attract predators of the likely perpetrators.

Signals may be distinguished from cues in that signals can be varied behaviourally by the sender (for example an animal can call or not call, as well as possibly use many varieties of a call), and involve some cost for the signaler to produce. In contrast, cues are typically always present, such as the warning or 'aposomatic' coloration of some poisonous species, and there are no extra costs associated with each usage.

In the animal kingdom every possible sensory information channel is exploited for communication. Sound waves are used, for example in song, grunts and calls, such as the low frequency calls made by elephants that travel through the ground and can be picked up by other elephants with their trunks and feet; visual signals are used in the form of colours and decoration, body language, gestures, facial expressions, light signals, dance, display, and even the way a nest is built and decorated, as by the hammerkop (*Scorpus ombretta*) to signal fitness to potential mates; chemical signals (see: **chemical communication),** include **pheromones** which play a role in partner selection, signalling alarm and the setting out of trails, aversive defensive chemicals, chemical territorial markings and social odours such as the chemicals exchanged between lions and domestic cats when rubbing their heads against each other that enhance bonding; vibration is used for example by the southern green stinkbug (*Nezara viridula*) to signal both gender and location through the vibration of leaves attached to plants or trees; electricity is used by some aquatic species, for example the frequency of the electric discharge of the whale-faced marcusenius (*Brienomyrus brachyistius*) is used by conspecifics to determine gender (see: **electric fields);** and touch, for example the licking used as a greeting by marmosets (*Callithrix jacchus*).

The specific channel used for communication depends on both the signal content, sensory ability of the species concerned as well as the prevailing environment for communication; for example pigs often use auditory signals to rapidly communicate socially as their natural woodland habitat is a barrier to visual signals.

Communication is generally focused on the needs of the sender or the receiver, linked to the survival of the individual or the species: to find a mate, to defend, to threaten, to mark territory, to coordinate hunting, to determine or establish a social hierarchy, to know something about the state of the sender (e.g. being prepared to mate), etc. The needs of the sender and receiver in an evolutionary context do not require that communication is always truthful: senders can benefit by using signals to mislead receivers. For example, roosters will sometimes peck at the ground, as if foraging, even when no food is present, in an apparent attempt to attract hens to their vicinity. ‘Honest’ signaling is more likely if the signals are expensive to produce. For example, crowing acts as an honest signal of social status in part because subordinates are more likely to be pecked by flock mates if they crow.

Communication is not limited to social animals, although communication among animals living in groups tends to be more varied (both in channel use and the repertoires employed) compared to those living solitary lives. For example, Bonobos (*Pan paniscus*) use facial expressions, gestures, calls, grunts, touch, grooming and even sex in communication (de Waal & Lanting, 1997), while the solitary living Giant Kangaroo Rat (*Dipodomys ingens*) communicates mostly by leaving scent trails in the sand and by foot drumming (Murdock & Randall, 2001).

The total repertoire of signal to meaning mappings is vast for human beings (the adult “mental lexicon” contains 50,000 - 100,000 words, depending on the level of education) compared to the signal repertoires available to other animals. For example, vervet monkeys living in Amboseli National Park in Kenya have three different alarm calls to signal danger: leopard alarm calls enticing vervets to run into the trees, eagle alarm calls causing vervets to look up, and snake alarm calls making vervets look down (Seafarth et al., 1980). Attempts have been made to artificially increase the total set of signals that are naturally available to chimpanzees (Hillix & Rumbaugh, 2004; Rumbaugh et al., 2003), dolphins (Herman et al., 1984), parrots (Pepperberg, 2000), and dogs (Kaminski et al., 2004; Rossi & Ades, 2008). For example, a border collie named Rico, who knew the names for at least 200 objects (as tested by retrieving these objects), was taught almost forty names for new objects in single trials, and was shown to remember these new names after a period of four weeks, making his performance “comparable to the performance of three-year-old toddlers” (Kaminski et al., 2004). Although the human like ability of “fast mapping” was claimed for the process of name acquisition by Rico, methodological problems in this and other animal studies have not refuted the suggestion that the size, structure, use and acquisition of the mental lexicon in humans is qualitatively different compared to other animals. The human mental lexicon encodes among other things complex relations (e.g., ‘later’ and ‘conclusion’), abstract categories (e.g., ‘planets’ and ‘recursive’), and syntactic features (e.g., ‘gender’ and ‘number’). With the (spontaneous) intention to convey a message humans normally produce 2-3 words per second without repeating the same item and while making only 1-2 mistakes per 1000 words. Humans learn signal to meaning mappings by using a **theory of mind** to understand word-reference (e.g. to understand pointing, or to understand what the signaller attends to), humans do not have to be taught which items should be learned from among the total available input (e.g., “this is not a car” does not contain a reference to a name (“not-a-car”) for an entity), and humans learn words without reinforcement (Bloom, 2004; Markman & Abelev, 2004). Although research continues to investigate to what extent these and other features are part of the signal to meaning mapping in other species, it is quite unlikely that all the features found in humans will be found in any single other species, due to differences in the evolutionary histories of humans and non-humans, including our closest primate cousins.

Most signals evolved for communication between members of the same species, but some signals are also used for inter-specific communication. For example, prey species use a variety of signals in response to the presence of potential predators, such as 'alarm calls' by chipmunks or 'stotting' by gazelles (see: **alarm reaction**). These signals may have evolved as a way of warning group mates, but they also function to inform predators that their presence is known and that the probability of success is therefore low. By attending to such signals the predator saves the costs associated with (unsuccessful) pursuit.

It is generally accepted that signals evolved by natural selection out of behaviours that had non-signal functions (Hauser, 1996). E.g,., urinating has in some species developed into a signal for territory marking. Although historically emphasis has been given to the role of selection operating mostly on the sender to convey unambiguous information for the recipient, during competitive interactions selection also operates "against individuals using displays that are highly predictive of their subsequent behaviour" (Hauser, 1996). While it is in the interest of the sender to deceive and to manipulate the truthfulness of a signal, it is in the interest of the receiver to decode a signal reliably, and to resist any manipulation successfully. In studying the evolution of communication, and in comparing the signal to meaning mappings between different species it is important to focus on both senders and receivers, and on both truthful and deceitful aspects of communication (see: **deceit behaviour** and **honest signals**).

For people working with animals, an understanding of their signals is especially important, and arguably many of the animals that we have domesticated have become proficient at recognizing the signals we use (see: **dog**). Although, there appear to be some common properties to certain signals (for example, short high pitched rising tones tend to be used by humans to communicate the need to speed up across taxa, and longer low descending tones tend to be used to inhibit behaviour), similar signals may also be used quite differently between taxa, for example the bearing of teeth by a human may represent a friendly smile, but a similar gesture by a dog can have a defensive/aggressive meaning. A failure to appreciate this is believed to be one factor contributing to the higher rate of dog bite injuries in children (see also: **bite prevention programmes**).

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