Communication: Uniquely Human or Evolutionarily Ancient?

By Ashley Shipley

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0. Abstract:

As humans, we commonly believe that our ability to communicate with each other sets us apart from other animals. In this essay, I discuss examples of communication in prairies dogs, baboons, moths, domestic dogs, and dolphins to dispute this belief. I also describe the four main four of communication – acoustic, visual, chemical, and tactile – and how all four are used in various contexts throughout the animal kingdom. I ultimately conclude that communication, far from being unique to humans, is present in just about every species on the planet, even outside of the animal kingdom, and is therefore an example of an ancient trait of life that appeared early in evolution.

1. Introduction:

One way in which humanity is distinguished from the countless other species that inhabit planet Earth is through our ability to communicate. Whether it be through verbal speech, gestures, or facial expressions, humans communicate wants, needs, and emotions to each other every day. In some ways, our ability to communicate with each other is unique and a consequence of our evolutionary history, such as our complex spoken languages, but other forms of communication appear to be somewhat shared with many other, sometimes very distantly related, species. It is the myriad ways that these other species communicate that will form the basis of this essay. Before I discuss this, however, it seems pertinent to discuss what communication is as, although it may seem intuitive to some, the concept of communication has proven difficult to define.

The most simple and broadest definition of communication is one that simply requires the transfer of information from one individual to another. There is no requirement for the sender of the information to consciously intend to send the information and there is no need for the receiver to reply or acknowledge the receipt of the information. As long as a signal has been sent, in the form of a call or a visual display for example, and received, information has been communicated[1].

A slightly different definition of communication states that communication occurs when information is conveyed to a receiver and due to this information, the receiver changes their behaviour[2]. This more complex definition changes what could be considered an innate, automatic act to a more voluntary, evolutionarily relevant one. It is possible that both the sender and the receiver may benefit from the transfer of information as the sender may require the receiver to change their behaviour to increase its own likelihood of survival, and the receiver may benefit from the information that the receiver provides. This is not necessarily the case, however. It may be that the sender alone benefits from the change in behaviour in the receiver while the receiver does not benefit or may be disadvantaged by the information that it receives or its change in behaviour. Similarly, the receiver may obtain information through 'eavesdropping' which would benefit them but could severely disadvantage the sender[3]. It is likely that, throughout evolutionary history, there has been a so-called 'arms-race' between senders and receivers and the communication events that we see today are the consequence of this, i.e. communication occurs in a way that increases the possible benefits while decreasing the possible costs. Due to its narrower and evolution-focused perspective, it is this definition of communication that I will be using throughout this essay.

But why and how is communication used? As humans, we communicate for a range of reasons. We communicate to introduce ourselves and place ourselves within certain socially ordained groups, to show health status, to find mates and initiate mating, to display our emotions and intentions, and to bring certain events or objects to the attention of others. All these reasons are also relevant to non-

human animal species[4], especially those that live in complex societies like our own that require coordination and cohesion on a group level[1]. We, and our fellow animals, also communicate in a variety of different ways, which will be the subject of the next section.

Finally, the relationship between the sender and the receiver is of importance. Typically, individuals will communicate with others of the same species (intraspecific communication) but in some situations, especially in the event of strong and historical cohabitation between two species, communication with individuals of a different species (interspecific communication) may occur. Additionally, individuals may communicate differently with those of the same sex (intrasexual communication) and those of a different sex (intersexual communication). Finally, there are some species that communicate with themselves (auto-communication).

This essay first discusses the types of communication available for most animal species before turning to case studies for the five different sender-receiver relationships highlighted above. For length and focus I have decided to include only one species per relationship and have chosen species that best show the range of communication and species types available. This essay is therefore not a comprehensive account of all types of communication within a single species nor a definitive discussion of all the ways in which certain types of communication occur in all species. This essay is a showcase of five interesting species and some of the ways in which they communicate.

2. Types of Communication:

As communication is simply the transfer of information, the form that communication can take varies widely. Sounds, gestures, odours, and touches can all be used to transmit information from one individual to another and each mode of communication has unique advantages and disadvantages which dictate when they are used[5]. Additionally, electricity and vibrations can be used to communicate in a few species but as these modes are uncommon and do not relate to the species discussed in this essay, they will not be discussed further.

2.1. Acoustic Communication:

Acoustic communication typically occurs through vocalisations as produced by a vocal organ such as the larynx or lyrinx[1] but may take the form of any other behaviour that produces sound such as lip-smacking or breast-beating[6]. Communication through sound is highly abundant throughout nature as it can be used in a wide range of environments[2], including both in and out of water[5]. There are

several advantages to using acoustic communication such as the ability for information to be transmitted over very long distances and at any time[5], and the ability to finely control the length, intensity, and frequency of the communication[2]. A disadvantage of acoustic communication, however, is that it is more likely to be 'intercepted' by eavesdroppers than some other forms of communication due to the dispersal of soundwaves, which may potentially alert predators to the presence of their prey, for example. Additionally, the large dispersal of soundwaves may make localisation of the sender by the receiver more difficult than more short-range communication methods[5].

Acoustic communication may be used to alert individuals within the same group to the presence of food or predators but may also be used in contact contexts such as mating, alliance formation, and mother-infant relationships[6].

Furthermore, acoustic communications, specifically vocalisations, are effective in producing specific behaviours in the receivers as the nervous system can be directly affected by sounds. It has been shown, for example, that an increase in motor activity can be stimulated by rapidly pulsating signals that increase in pitch while a decrease in motor activity can be achieved through continuous sounds that decrease in pitch. Specific sounds may also be difficult to ignore which is advantageous when producing alarm calls or when an infant is attempting to catch the attention of their mother[7].

2.2. Visual Communication:

Visual communication may take the form of gestures or movements, or body postures or ornaments[5] and are typically temporary but may be permanent in some cases[2]. This mode of communication tends to be used during courtship or aggressive rituals and requires the receiver to be able to see the sender. Therefore, visual communication is most commonly seen in open environments during the daytime. The requirement for close contact between the two individuals and the temporary nature of most communications are advantageous as the likelihood of 'eavesdroppers', especially unnoticed 'eavesdroppers', is reduced compared to acoustic communication. However, it does limit the utility of the communication mode as it cannot be used when individuals are out of eyesight[5].

It is common, preceding or during aggressive encounters, for males to take on an 'erect position' to show strength and size and, during infancy, for children to use 'begging gestures' to obtain food from a parent[6]. These and many more visual signals are used widely throughout the animal kingdom and tend to resemble each other in distantly related species, indicating that visual communication is an evolutionarily ancient method of communication that many species display to this day.

2.3. Chemical Communication:

Chemical communication is achieved through the transfer of olfactory (scent) signals produced in glands or bodily waste which are distributed through the environment either through the rubbing of glands or the depositing of faeces or urine. Once these signals are present in the environment, they may be tasted by nearby individuals, typically of other species, and are then referred to as allomones, or they may be carried by the air or water flow and smelt by distant individuals, typically of the same species, and are then referred to as pheromones. This form of communication is commonly used in mating, recognition, and territory marking[5]. Advantages of this form of communication include its ability to be transmitted over long distances[2], which can be important for solitary species during mating season, its long duration which would increase the likelihood that an intended individual would receive the signal, and the fact that it can be used in situations where other communication forms would not be effective such as in dark and crowded environments. Chemical communication, however, is a slow method for transmitting information and, as the signals are distributed via air or water currents, both direction to a receiver and localisation of the sender are likely to be more difficult than for other forms. This means that, although chemical signals can be used to alert others to dangers or the presence of food[5], they are unlikely to be as effective at doing so compared to, for example, vocal signals.

Like acoustic communication, chemical communication can directly affect the nervous system of receivers through the vomeronasal olfactory system that receives the chemical signal and transmits information to regions of the brain such as the amygdala which is important for motivation. The receiving of certain olfactory signals, therefore, may cause involuntary changes in motivational states which would then increase the likelihood of the receiver changing their behaviour in line with the wants of the sender[8].

2.4. Tactile Communication:

Tactile communication occurs when one individual makes physical contact with another[2] typically in intimate contexts such as during mating and courtship[6] or during infancy[5]. This form of communication is especially important in social species where it can be used to build and maintain relationships[2]. Advantages of this form of communication include the very short range which ensures that information is transmitted to only the intended receiver, and the short signal duration which means that information transfer can be tightly controlled and localised[5]. Tactile communication can only be used in a small number of situations where the sender and receiver are in close proximity[2] and the receiver is accepting of the communication attempt, therefore tactile communication is unlikely to be the only type of communication species use in specific contexts.

3. Communication Across the Animal Kingdom:

The rest of this essay will be dedicated to discussing examples of communication from different parts of the animal kingdom. From alarm calls in prairie dogs and communication between domestic dogs and humans to courtship and greeting rituals in silk moths and olive baboons and the fascinating phenomenon of echolocation in dolphins, animals utilise communication techniques for a wide range of reasons and in many contexts.

3.1. Intraspecific Communication:

3.1.1. Intraspecific – Gunnison's Prairie Dogs:

Individuals often need to communicate with other individuals of the same species for reasons such as mating, territorial defence, and predator detection[9]. It is this latter point that has fascinated researchers of Gunnison's prairie dogs (*Cynomys gunnisoni)*. This species of rodent is highly social and lives in colonies in the American Southwest and it has been discovered that they are able to produce unique alarm calls upon the detection of different predator species, causing different responses in receivers depending on the predator present. Although these alarm calls follow a similar pattern as predator warning vocalisations in other species, namely their loud volume[10] and short duration which cause flight responses in receivers[11], prairie dog calls contain information regarding the species of predator, the distance and speed of movement, and even features unique to individual predators that allow receivers to adapt their evasive behaviour according to species, level of threat, and even individual predator identity[10].

Gunnison's prairie dogs exhibit four unique calls and escape responses when threatened by red-tailed hawks (*Butea jamaicensis*), coyotes (*Canis latrans*), humans (*Homo sapiens*), and domestic dogs (*Canis familiaris*)[12].

3.1.1.1. Red-tailed hawks:

As an aerial predator, the hawk has two actions during a hunt, circling a colony and stooping down on to it. If a prairie dog notices a circling hawk, it gives a bout of calls which instructs the colony to stand alert. If a prairie dog notices a stooping hawk, the colony is alerted by a one-note call[10] which instructs only individuals in a 20m radius of the hawk to escape to their burrows, while the rest of the colony stands alert. This differentiated response is appropriate as when the hawk is circling the colony, the entire colony must be aware of the presence of danger, but none are directly threatened, whereas if the hawk is stooping, only those in its flight path are in danger, and the danger is

imminent[12]. As prairie dogs require long hours of foraging to survive, escaping to the burrow should only occur if the individual is in direct danger[9].

3.1.1.2. *Coyotes:*

Coyotes may be one of the greatest threats to prairie dogs and as such, alarm calls for the presence of coyotes are highly sophisticated. When an individual notices a slow-moving coyote in the colony it elicits a bout of calls which instructs all individuals to run to their burrow. If the coyote is far away, the prairie dogs stand at the entrance to the burrow but if it's is nearby, they enter the burrow. If, instead, the coyote is moving quickly, the call is picked up by multiple individuals, presumably to show an increase in the level of danger, but the response by the rest of the colony is the same as before. This response is appropriate against coyotes as it has been discovered that coyotes do not all hunt the same. Some walk through a colony and make opportunistic runs towards available prairie dogs, while others lie next to the entrance of a burrow for up to an hour, waiting for prairie dogs to appear. Watching the coyote's progress through the colony from the relative safety of the burrow entrance, combined with elements of the call which describe features of the individual coyotes, allows the prairie dogs to identify the coyote, or at least their strategy, and respond accordingly without unnecessary time in the burrow[10, 12].

3.1.1.3. *Humans:*

As humans can hunt prairie dogs from a larger distance than other predators, due to the use of guns, the most appropriate response to the presence of a human in the colony is a more cautious one than for other predators. A fast-moving human elicits a single note call from a prairie dog and a slow-moving human elicits a bout of calls, but no matter the speed of the predator, all individuals within the colony respond by entering the burrow[10]. It has been shown that prairie dog alarm calls contain descriptions of the size, shape, and clothing worn by humans so, similar to coyotes, prairie dogs seem to be able to identify individual humans and may adapt their escape response accordingly[13, 14].

3.1.1.4. *Domestic dogs:*

Due to their more erratic hunting style, prairie dogs are not in as much danger from the presence of a domestic dog within their colony than other predators[12]. A slowly approaching dog induces one prairie dog to start a bout of calls which instructs foraging individuals to stand alert where they are and any individuals within burrows to emerge and watch the predator. An increase in pace of the predator then causes the call to be picked up by more prairie dogs who continue to stand alert when

the dog is far away but enter the burrow when it is close enough to pose a threat[10]. As long as they are aware of the position of the dog within the colony, prairie dogs typically have enough time to the escape if they are directly threatened so remaining in their foraging area instead of retreating to the burrow appears to be the most appropriate response[12].

It should be noted that there is some evidence that, in the case of slow-moving terrestrial predators, e.g. domestic dogs, coyotes, and humans, there is little predator specificity to alarm calls. This specificity may therefore be encoded in the calls elicited by fast-moving predators, a much more dangerous threat[15]. This is controversial however and more research is needed to come to a firm conclusion on this point.

Finally, individual prairie dogs have different calls for the same predator and may even change their call. Dialects, for example, exist between prairie dog colonies, due to genetic isolation and habitat adaptation, which enables individuals to decipher between the calls of their own colony and kin, and another[16]. Additionally, female prairie dogs have been found to modify their calls during a single invasion. This may be due to vocal fatigue which causes a loss of continuity between calls in a bout. Alternatively, calls at the beginning of a bout may be longer, higher in pitch, and more varied in frequency than later calls as the first calls must alert nearby individuals and allow them to locate the caller easily while the later calls simply need to sustain the awareness. Another theory suggests that the decreasing number and rate of calls towards the end of the bout indicates decreasing danger from a predator that is moving away[17], which predators often do when they hear alarm calls[9].

In conclusion, Gunnison's prairie dogs use acoustic communication in the form of alarm calls to transmit information such as predator species, speed, distance, identity, relative threat level, and kinship to promote appropriate escape responses in their colonies which ultimately increases the likelihood of survival.

3.1.2. Intrasexual – Olive Baboons:

There are times when an individual may wish to communicate only with individuals of the same species and the same sex. This is the case with male olive baboons (*Papio anubis*) who greet other males in a highly ritualised way. Olive baboons of sub-Saharan Africa live in societies composed of males and females of different ages and so have developed complex communication techniques to maintain the stable social group. Males often leave and rejoin the group and so it is necessary for social, and especially dominance, relationships to be constantly established and maintained. This is done through a neutral greeting ritual[18].

3.1.2.1. The greeting ritual:

One male, often the more dominant, quickly approaches another male with a 'swinging gait', 'lip smacks' and a 'come hither' expression which expresses friendliness and sets the encounter apart from other, more hostile, exchanges. The second male, the receiver, can either accept or reject the request for greeting by reciprocating the friendly behaviours or enacting evasive behaviours, such as turning away, respectively. Approximately a quarter of greetings are rejected, a figure that is lower between two older individuals and higher between two younger individuals. If the greeting is accepted, behaviours such as the presentation of the posterior, grasping, mounting, and genital touching can occur, either symmetrically or asymmetrically. Even when the greeting is accepted, it is broken off before it is completed 20% of the time, this figure being higher again when a younger individual is involved. If the greeting is completed, as it is approximately 50% of the time, one or both participants quickly walk away with the same 'swinging gait' as used in the approach[19, 20].

3.1.2.2. Meaning of the ritual:

This greeting ritual is the most common type of interaction between two male baboons, with a rate of 1.2 per hour[18], and has been seen in all males within a social group[19]. The ubiquity of the communication behaviour, therefore, indicates that important, functional information is being transferred from one individual to another during the greeting. As it has been shown that the most completed greetings occur between two older individuals, it has been suggested that greetings are a way of forming coalitions, primarily to gain access to females[20]. Although they have a lower status and fighting ability compared to younger males, older males actually have a higher success in accessing females due in part to their ability to 'team up' and challenge a younger male. This means that their reproductive success is reliant on their ability to make alliances and explains the high levels of completed greetings and alliances seen between older individuals. Greetings between a young individual and an older one are the next most common and this may be because the younger individual can gain access to females through increased tolerance by the older individual, and the older individual can gain access to food through increased tolerance by the younger individual. Such benefits cannot be achieved in young-young alliances as the social status and thus the resources that each individual has access to is similar for both participants. This, combined with the tense and sometimes aggressive greetings observed between two young males, may be a reason for the lower rate of completion in this age pairing. However, greeting attempts are frequent between young males which indicates that greetings are used to explore dominance relationships in this age group, with pairings of individuals of similar status more likely to fail. Finally, there is a theory that alliances formed during greetings can be beneficial not just for access to resources but also during aggressive

encounters. A short version of the greeting has been observed between two individuals who then go on to form an 'aggressive coalition' against a common foe. The friendly behaviours that constitute the request for greeting in a neutral setting are generally lost in the more aggressive context so the receiver must be aware of previous 'agreements' with the sender in order to form a coalition[19].

In conclusion, visual (swinging gait, 'come hither' face), acoustic (lip smacking), and tactile (touching and mounting) communication is used by male olive baboons during greetings to establish dominance relationships and form coalitions which are beneficial in resource access and during aggressive encounters. An important aspect of the greeting is the visual and acoustic communication that frames the greeting as a friendly exchange. This metacommunication is widely used throughout the animal kingdom to give information about the communication that will follow. Without this metacommunication it is likely that most greeting attempts would escalate into violent encounters with injuries common, especially in young-young pairings. As it is, however, only 7% of greetings end in aggression[19] and none cause injuries[20], even though any interaction that places one male's genitals in the hands of another is considered very risky.

3.1.3. Intersexual – Silk Moths:

More common than communication between individuals of the same sex is communication between individuals of different sexes, most commonly for reproductive purposes. Because reproduction is a necessity in every species, intersexual communication is ubiquitous but can be incredibly varied depending on the communicative abilities of the individuals. An interesting form of intersexual communication occurs in insects, with silk moths (*Bombyx spp.)* being a good example.

After she emerges from her cocoon, the virgin female moth releases chemicals, or pheromones, from her scent glands[21]. In the case of silk moths, this is a 10:1 bombykol:bombykal mix for domestic silk moths (*Bombyx mori*)[22] or bombykol alone for wild silk moths (*Bombyx mandarina*)[23]. No matter the composition of the pheromone mixture, the chemicals are distributed by air flow[8] and are detected by the chemoreceptors on the antennae of male moths[21]. When a male moth detects the pheromone composition specific to his species, he becomes highly active and attempts to locate the communicating female by following the pheromone trail back to its original location[2]. It is at this point that the wild and domestic moth's behaviour diverges.

3.1.3.1. Wild Silk Moth (Bombyx mandarina):

When a male wild silk moth detects the presence of bombykol, he begins to fly upwind. Flights upwind occur in very short bursts so that the moth can frequently check that he is going in the right

direction. If he continues to detect the pheromone, he will continue his flight upwind, but if he loses the chemical, he will move side-to-side to recapture the scent and make sure that he is following the trail accurately[8]. Once the male finds the female, they mate and then separate, ready for future matings.

3.1.3.2. Domestic Silk Moth (Bombyx mori):

As the domestic moth has lost its ability to fly, courtship behaviours in this species are slightly different to those in the wild species. When a male moth detects bombykol, instead of flying upwind to find a mate, he instead becomes alert and starts to vibrate his wings, producing an air flow that will aid in the localisation of the communicating female. The male will then begin to run in circular and zigzag motions in the vicinity of the female which ultimately ends with physical contact with the female's genitals and thus compulation[21]. A further difference between the wild and domestic species is the presence of the additional chemical, bombykal. The courtship behaviour in domestic moths can be triggered by bombykol alone so this second, less abundant compound does not activate the behaviour. Instead, bombykal inhibits the courtship behaviour by interfering with the neural response to bombykol within male moths, requiring an increased amount of bombykol, and hence pheromone communication, to trigger the maximum response. It is unknown precisely why this inhibition mechanism is present[24], however it may be that, increasing the amount of bombykol needed to trigger the courtship behaviour may prevent mating between different species of moth, especially as wild silk moth mating is also triggered by bombykol alone.

In conclusion, chemical communication is used by female silk moths to advertise their availability to mate to males of their species. This is a necessary form of intersexual communication and has evolved to be effective over a range of distances and specific to individual species to avoid interspecific mating.

3.2. Interspecific Communication:

3.2.1. Domestic Dogs:

Communication between individuals of the same species is common and used for a variety of reasons as outlined above. Communication between individuals of different species, however, is considerably rarer and quite controversial. In the wild there are few, if any, reasons for different species to share information such as the location of resources due to inherent interspecies competition, and communication may even be detrimental if between a predator and prey. Therefore, interspecific communication is likely to occur in two main ways: in the wild when one

species is able to 'eavesdrop' on another species, providing benefit to the receiver and either neutral or negative effects to the sender[25], or in a domestic setting when two species live in close proximity and communication between the two is necessary for survival[26]. It is this latter mechanism that exists between domestic dogs and humans. Note, this section will discuss the ways that domestic dogs communicate with humans but will not consider the many ways that humans communicate with dogs. Most, if not all, of the sources used in this section discuss both sides of the relationship so please read these if more information on human communication is needed.

For the past 30 000 years[26], the social unit of domestic dogs has been not the intraspecific pack of their wolf relations but the interspecific human family[27]. Therefore, it has become necessary for dogs to be able to communicate with other members of their unit, in this case individuals of a different species. Interspecific communication in dogs takes several forms, most commonly visual, acoustic, and tactile communication.

3.2.1.1. Visual communication:

Just like other species, dogs use body postures and gestures to show dominance status. Alert, upright postures with both the head and tail held high indicate dominance while postures that minimise the size of the individual signal submission[27]. The most interesting use of visual communication, however, is its use as metacommunication, similar to the beginning of baboon greeting rituals. The commonly used 'play bow' is used by dogs with humans, other dogs, and members of other species, to initiate social play. As play may include actions taken from other behaviours such as courtship and aggression, it is important for players to know that the current exchange is neutral so that injuries do not occur. This is especially necessary when play occurs between different species where normal bouts of fighting may be more common[28, 29]. Another way that dogs signal that they wish to begin communicating is through eye contact. Eye contact, combined with eyebrow raising, catches the attention of humans as it is a human-like behaviour and allows the dog to perform 'showing behaviours' which direct the human's attention to the object of concern. This is necessary when the dog is asking for help or wishes to gain something from the human, such as food. In addition to acting as a metacommunication signal, eye contact, as in humans, aids in the maintenance of social bonds. Neither of these things are produced in intraspecific eye contact between dogs so the communication mechanism appears to be uniquely interspecific[26].

3.2.1.2. Acoustic communication:

A defining characteristic of domestic dogs is their bark, and these vocalisations can communicate may different things. For example, like with eye contact, vocalisations can be used to gain the attention of humans[26] either at short range, as with barks, yelps, whines, and growls, or long range, as with howls. Barks specifically appear to resemble human speech[27] which may account for why they are effective in catching attention. The sound features of barks change depending on the context and emotions of the sender which allows the human receiver to accurately discriminate between aggressive barks, which tend to be lower in frequency and more rapidly pulsating, and happy vocalisation, which are higher pitched and have a slower pulse rate. This means that vocalisations, specifically barking, can be used and accurately understood in a variety of contexts such as in warning, during play, in greeting, and when asking for food[26].

3.2.1.3. *Tactile communication:*

Physical contact between dogs and humans is common and, as in many intraspecific relationships, can maintain social bonds, aid reconciliation after conflict, and generally reduce stress for both parties[27]. Although common in intraspecific relationships, tactile communication between species is rare and its presence in newborn puppies suggests that, through domestication, dogs and humans have achieved a unique interspecific relationship which is more akin to those between individuals of the same species than those of different species.

In conclusion, visual, acoustic, and tactile communication are used by domestic dogs to communicate with humans, both members of their social unit and strangers. Many forms of interspecific communication produced by dogs is similar to intraspecific communication between humans, so it is likely that, during the domestication process, dogs evolved these communicative abilities to better survive within their new environment.

3.3. Auto-communication:

3.3.1. Dolphins:

Up until this point in the essay, the terms sender and receiver have been used to describe two different individuals, one who sends information and another who receives it. In this final section, however, I will discuss the interesting phenomenon of auto-communication: a communicative relationship where both the sender and receiver are the same individual. To demonstrate this type of communication, I will discuss echolocation in dolphins.

In the sometimes dark and murky depths of the sea, it can be difficult for individuals to see their prey or even detect their own orientation. Species such as dolphins, therefore, need an alternative to vision in order to survive. This alternative comes in the form of auto-communication, more specifically echolocation[30]. When a dolphin wishes to gain a picture of their environment but cannot see, they may pass air through 'phonic lips' within the nasal passage which allows the production of clicks through the melon, an organ in the forehead. These clicks disperse throughout the environment and, when they encounter a solid mass, are reflected back to the sender as an echo. The sender now becomes the receiver as the echo enters the lower jaw and is processed by the brain. The brain compares the outgoing and incoming signal to produce an image of the environment including the distance, direction of movement, and even species of any obstacles. Dolphins are therefore able to hunt and avoid obstacles such as fishing nets even in the darkest and noisiest of conditions[2, 5, 30, 31, 32].

Great accuracy in visualising the environment can be achieved through altering the signal that is produced. In water, for example, low frequency signals are able to travel long distances while higher frequencies are not. Therefore, to gain a general picture of the environment and detect potentially distant obstacles/prey, a small range of low frequencies are used, with the duration typically being long. However, when the individual wants more localised and accurate information, for example when preparing to hunt, a larger range of higher frequencies are used, typically with very short durations to enable better temporal resolution due to the fast speed of sound in water. Different species of dolphin produce unique signals that vary in both duration and frequency and so some species are better adapted to general environment sensing and others are more adept at localised visualisation[5, 30].

In conclusion, dolphins use acoustic communication to complement or replace the visual sense when it is at its least effective in order to produce an accurate picture of their surroundings. This is a form of auto-communication which allows individuals to detect and localise prey and other obstacles hence aiding in their survival.

4. Conclusion:

This essay has discussed the four most important forms of communication – acoustic, visual, chemical, and tactile – and real-world examples of different communicative relationships – intraspecific communication between prairie dogs, intrasexual communication between male olive baboons, intersexual communication between silk moths, interspecific communication between domestic dogs and humans, and auto-communication in dolphins. I hope to have conveyed how universal and ancient communication is within the animal kingdom, as it exists in such diverse

groups as insects and primates, and therefore how important it is for survival. In several of the examples that I have chosen, multiple different forms of communication are used in a single context, and it is likely that, through the many different communicative contexts a species is capable of engaging in, all of the main forms of communication described here as well as less common forms not discussed can be observed for many animal species. This shows how varied communication can be, how different communication forms are used depending on the context, and, again, how communication evolved early in evolutionary history. I decided to restrict this essay to the animal kingdom, to one species per communicative relationship, and to one communication context per species for length, focus, and conciseness. Needless to say, communication is not restricted simply to the animal kingdom as other eukaryotes such as plants and even prokaryotes such as bacteria have been shown to communicate. This lends significant credence to the previously stated assumption that communication evolved early in history and is a fundamental requirement for life. As such, all species communicate in some way, be it simple density sensing as in bacteria or complex verbal and non-verbal communication as in humans. Communication has long been believed to be the trait that sets humans apart from our fellow species, but recent research has shown this to be untrue. Perhaps studying the communication techniques present in other species and showing how they are not so different from our own is a step in reducing the philosophical 'distance' between humans and other species and producing a more harmonious relationship between us and the rest of the natural world.

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