Cephalopod cognition, scholastic psychology

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Introduction

The article examines cephalopod sensation, behavior and cognition from the point of view of modified scholastic psychology mainly according to Thomas Aquinas. The data about non-mammalian, nevertheless intelligent, animal is examined with the help of non-standard ideas in order to test how efficiently an objective framework can be constructed to discuss intelligence in general.

We have organized data about cephalopods according to the scholastic concept of the soul. The data comes from research and observations conducted in field and in laboratory. Although from the scholastic point of view the existence of language is sufficient to conclude that an animal is rational, the criterion of language does not enter into scholastic definition, but rationality is determined by the use of certain mental faculties. Only detailed familiarization with the examined entity can bring about conclusion on intelligence.

One logical consequence of the scholastic theory of sensation is that all information is present in sensory perception. Expressed critically, if the role of the active intellect of the scholastic psychology is to abstract the universal elements from particular details of the *phantasma* created by sense impressions, then already the sensible species must contain such information that can be abstracted. Is there inconsistency: The existence of conceptualizing ability in the sensitive faculties means the active intellect losing its role? In reality, there may be conceptualizing ability in the sensitive faculty without depriving the active intellect of the important abstracting role. Sensitive faculty consists of external and internal senses and, just as there are differences between the external senses of different animals, there are differences in conceptualizing abilities of the internal senses. The highest conceptualization or abstraction is achieved by the active intellect. Jacob von Uexküll´s Umwelt is very important for understanding

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correctly conceptualization. The common environment contains all information possible to attain. For different species, however, some information is available and some lost because of the different Umwelt they live in.[1] All the information contained in the Umwelt of the animal is relevant for survival, while the lost information is not. The Umwelt depends on the sensitive faculty of the animal, to use scholastic terms, the five external and the four internal senses. Depending on how developed the external senses are and how much conceptualization the internal senses are able to do, the Umwelt is different for different species but pretty much the same for animals within same species.

Scholastic philosophy is open to the existence of rational animals not belonging to the species Homo sapiens. The encounter of Anthony with the horned creature reported by Jerome was considered authoritative and was supposed to be taken for description of true event and hence the description of a rational animal. Another authority, Isidore of Seville (c.560-636), was following the tradition of antiquity, described human-like rational creatures with distinct bodily features different from Homo sapiens. Scholastics had to accommodate these facts because of the authority of the authors, but it was easy because they did not contradict Aristotelianism.

Anima, soul, cannot be connected to the brain exclusively, not even in humans and other known organisms, as some faculties of the soul do not require nervous system. Plants have vegetative faculties only; animals have sensitive and vegetative faculties, while rational creatures have also intellective faculties. Speaking in modern terms, the intellective faculty and part of the sensitive is connected to brain activities. This was in some extent realized in the Middle Ages.[2] The remaining sensitive faculties can be connected to the nervous system outside the brain, while the vegetative can be viewed as genetically programmed: Nutrition, growth and reproduction. Although in different animals belonging to different taxonomic groups the activities of the vegetative faculties are controlled by diverse organs, the faculties are common to all living creatures. As in animals there are both vegetative and sensitive faculties and in humans there is also the intellective faculty, it is clear why "soul" cannot be equated with "mind".

Although mostly there is be no confusion due to equation[3], in analysis of animal cognition it is impossible to use the term "mind" only.

Vegetative faculties

The vegetative faculties are responsible for nutrition, growth and reproduction. These are common to all living beings (Summa Theologiae I, 78, 1). In coeloid cephalopods, nutrition differs significantly from mammalian due to the high percentage of food conversion efficiency. In mammals, only 10% is utilized to gain weight and grow body tissue, while in cephalopods it is 50%.[4] They grow during most of their life and only in reproductive adulthood, which is around 1/10 of their lifespan the augmentative faculty is directed towards developing sexual tissues instead of somatic growth. With the onset of maturity, the generative faculty becomes active. Reproduction is a unique event in the life of cephalopods, as they stop being interested in food after mating and both male and female die after their roles are fulfilled. Cephalopods reach reproductive maturity in 50 to 1400 days depending on species, the high value being for the Giant Pacific Octopus (*Enteroctopus dofleini*) in a survey 1019 days.[5] From a scholastic perspective, mating once in a lifetime and fast decaying afterwards is not a bad alternative for an intelligent species. The predominant behavior difference between male and female familiar from other species including our own is absent for most of the life of the cephalopods. Also is gone the stress of finding a mating partner and related competition. What would be perceived as important from the scholastic perspective is the diminished need to control the strongest passion of all. Sexuality was since antiquity frequently viewed as taking energy away from noble activities. Epictetus (AD. 50-138) advocated celibacy for devout philosophers in order to be free for work.[6] Early Christian authors considered the only acceptable sexual activity one that is directed to procreation, while seeking pleasure was evil.[7] Aquinas agreed that evil is inseparable from the carnal intercourse[8] and should be avoided as much as possible. Cephalopod intelligence would not need to take care in avoiding other then reproductive intercourse because of the unique nature of the event and energy could be

devoted to activities pertaining to higher faculties of the soul. Although the death of parents coupled with solitary lifestyle in some cephalopods would represent a challenge for handing down knowledge, it could be addressed by scholastically very much acceptable discipleship resembling the ways of eremite monks and nuns.

Sensitive faculties

External senses Sensitive faculties are potencies of the soul.[9] They are common to all animals, including humans. Scholastic philosophers distinguished within the sensitive soul the five external senses of smell, taste, touch, hearing and sight and the internal senses having the task of processing the information from external senses. In modern terms, the sensitive faculties are regulated by the nervous system and especially the brain.

Vision was considered the most noble, most spiritual of the external senses, because it has no "immutation" either in its object or in itself.[10] Aquinas meant the lack of direct contact between the organ of vision and its object. Naturally, photons were unknown in the middle ages, but even taking into consideration modern knowledge, scholastics could argue that photons are the most subtle entities perceived by any sense, so vision is still the most subtle of senses. Vision is well developed in coeloid cephalopods. They have eyes similar to mammals with relatively good acuity. The eyes of octopuses have a small area of binocular overlap in front of about 10%. Each octopus has a preferred eye to focus on details, but they probably need to lift and lower their head in order to get more clues about the relative distance by motion parallax as do many mammals. They cannot perceive colors[11], but as water filters out the red end of the spectrum there is less to be utilized by color vision. Very few octopus species are daytime active; most of them are animals of twilight or near dark, color visibility is weak in those circumstances. On the other hand they are able to perceive the plane of polarization of light, which gives them an additional dimension instead of color. This ability may help octopuses to penetrate the camouflage of fish by over-riding their counter shading.

Touch is more important for cephalopods than vision. Interestingly, in Aquinas the sense of touch is decisive for intelligence. Not only will species with more developed tactile sense be more intelligent, but individuals within the species follow the same pattern[12]. All the other senses are based on touch, the organ of which is required to be a medium between contraries, hot and cold, wet and dry, and is in potentiality with regard to contraries. The more this organ is reduced to equality of complexion, the more sensitive it is. According to Aquinas the intellective soul should be united to a body reduced most to equality of complexion. Thus the intelligence is suited for animals with the most sensitive tactile sense. Taste is closely related to touch; it is "a kind of touch"[13]. Taste accompanies the touch in the tongue[14] that is a specific place in the body.

For the giant Pacific octopus, *Enteroctopus dofleini,* one experiment showed how important chemotactile cues are in problem solving. Octopuses learned to open jars and take out crabs faster if the jars were treated on the outer surface with herring mucus.[15] Octopuses also ignore empty mollusk shells whose valves had been glued together. [16] As the suckers of the octopus have both touch and chemical receptors[17], it is in this case not distinct from "species of touch distributed in the body" and differs only by the subtlety of immutation.[18] Touch proper must be in direct contact with the explored object, whereas taste receptors react to the more subtle cues. This combination greatly enhances the tactile sense of the octopus, which is far more powerful than human tactile sense.

Octopuses have an olfactory organ, so they can sense chemical cues from distance. Although the structure of the organ was described[19], a lot about this sense remains unknown. There are some speculations about the organ perceiving sexual pheromones, but opinions are divided whether it is by the help of chemoreceptors that octopus males home in on females. If this is the case, octopuses use a form of chemical communication. As they are solitary dwellers for most of their lifespan, without significant social contacts[20], potential intelligence evolved from octopuses could develop this less intrusive chemical communication rather than other forms like tactile or visual. It is intriguing to

think just how much the form of communication would be comprehensible for a species with verbal communication such as humans.

Cephalopods have no ears. The scholastic definition of sound as caused by percussion and commotion of air[21] or other medium, for example water, and clearly enables cephalopods to perceive it. Lacking a separate organ is not a defect, if the lack of it does not affect the body adversely. A blind human has a disadvantage, but the mole does not, for if it would have eyes, the particles of earth would injure it. Underground vision is simply not necessary.[22] The octopus is considered a "perfect" animal (imperfect animals have exclusively the sense of touch and possibly taste and lack the ability for local motion)[23], the ability to perceive the commotion of the water is sufficient for its lifestyle.

Internal senses The incoming sense perceptions are organized by the *sensus communis*, the common sense of the scholastic psychology. The sense organs themselves cannot do the separation of stimuli, in the words of Aquinas "neither sight nor taste can discern white from sweet".[24] Stimuli from the same sense organ are also organized by the common sense, the power being present even in primitive animals. In the narrow Umwelt of the tick with only photosensitivity, smell and temperature play roles.[25] Nevertheless for the survival of the animal it is essential that warm and cold are distinguished, and thus there is *sensus communis*, a power different from but connected to the external senses.

More complex animals require other internal senses in order to function properly. The tick may eat only once and after that lay her eggs and die, but octopuses spend some time foraging for food and therefore need more complex capacities. Thus octopuses should have an imaginative power to retain the forms apprehended by senses. Further, perceiving something to be useful, friendly or unfriendly is performed by the estimative power, while all these are retained in memory or memorative power. Finding prey, avoiding predators, occupying and building a home and even simply moving around pertain to the activities of perfect animals and involves all the internal senses. Avoiding predators is purely instinctive and regulated by the estimative power.[26] Interestingly, the same

faculty in humans is called cogitative power or particular reason, which the "medical men" assign to the middle part of the head (ibid.). Similarly, memory can be found both in perfect animals and in humans, but in humans it is connected to the intellective faculty, whereas in animals it is in the sensitive. Cogitative power and memory in humans are not considered to be distinct powers from the estimative power and animal memory, only to be more perfect [27]. The only power distinguishing humans from animals is intellect or reason[28] , one of the faculties of the intellective soul, a very interesting fact for the issue of animal cognition.

Inasmuch as memory apprehends individual things or events from the past, it is in the sensitive faculty, but the intellective memory is concerned with "retaining the species"[29], that is, with universals. Cephalopod mollusks are heavily dependent on learning despite of short lifespan, no parental care and imprinting.[30] Learning, on the other hand, much depends on the ability of the animal to retain information, which is the role of the memorative power. Cephalopod learning is environment-dependent rather than social-dependent, as most of them are solitary animals. Even species of squids that swim in schools have only limited social interactions.[31] Although it appears that cephalopods have long term and short term memories, octopuses in trials started to forget which stimulus was rewarded and began to choose the alternative after one week of testing. It was found that octopuses asymptoted at seven of ten positive choices before shifting attention to the alternative. This may seem serious temporal limitation on learning, but in reality it is a very successful adaptation of the memory duration to the need of the animal. Switching choices was observed in the field, for octopuses returned to the same den after foraging trips for approximately a week and then moved to another area, possibly because suitable prey was depleted.[32] From scholastic perspective, a serious temporal limitation to the memory pertaining to sensitive faculty is not a disadvantage if it serves the survival of the animal. The memorative power of the intellective faculty, if present, must be of very long duration, since it retains the species unchangingly and lastingly.[33]

In one study trials with *Octopus vulgaris* with visual stimuli only failed to show tendency for learning, but trials with *Enteroctopus dofleini* providing both visual and chemical cues showed that octopuses indeed learn to open jars.[34] Of course, long term memory is still not necessary for learning the relatively complicated procedure of removing a lid. The lifestyle of ten days home range occupancy suggests that spatial memory should not be long term.[35] Octopuses find new dens approximately every ten days during their non-reproductive adulthood and use efforts to modify the home. This suggests the possibility of concepts. While it is questionable whether octopuses have universal concepts such as "home" to which they compare every potentially suitable den during their search, from their behavior it is clear that they have some expectation. Octopuses clean out the suitable crevice, modify the entrance with rocks and keep up the maintenance work for the entire period of occupation. The correlation of unmodified entrance size with number of stones brought to block it was around 0.8, a tool use by definition [36] and thus the modifications to dens seems purposeful. If the modification is instinctive, the ability belongs to the estimative power of the sensitive faculties. If, on the other hand it is not instinctive but deliberated according to a singular preconceived expectation, it belongs to the cogitative power and points towards complex mental processes. It is easy to see a possible evolutionary path in octopuses proceeding from singular expectation to universal concept, then a plurality of concepts. In such case the memory would belong to the intellective power that retains the species abstracted by the reason from plurality of examples in the phantasm of the sensitive soul.[37]

There are activities in octopuses indicating the beginnings of *vis cogitativa*, complex mental processes. Trial and error learning with bivalve shells and penetration technique switching in *E. dofleini* clearly shows the ability to solve prey handling problems. Octopuses could apply one of the two alternative techniques even in an unusual situation, when the bivalve was wired shut.[38] Octopuses are highly exploratory animals and in captivity this manifests itself in taking apart things in their tanks, sometimes the entire support system. While the exploratory behavior and the habit of approaching every novel item may be

instinctive, octopuses also exhibit play-like behavior. In trials several octopuses appeared to play, while in one case a floating bottle was sent 20 times to the opposite end of the aquarium to be returned by the inflow siphon.[39] These characteristics could be a good starting point for evolution towards advanced intelligence.

Intellective faculties

The presence of the intellective faculty is the why an animal is rational. The content of this faculty distinguishes brutes from humans. Memory, understanding and will are one mind.[40] Although scholastics treated the intellective soul as fundamentally different from other faculties, this is an arguable position. Aquinas presented arguments against the subsistence of human soul and even if he answered these objections, there are indications from his philosophy that the powers of the intellective soul can be treated as simple extension of sensitive faculties. In humans the estimative power is called cogitative power or particular reason. It compares individual intentions the same way intellectual reason compares universals.[41] Suarez (1548-1617) explained that through this faculty humans deal with particular ideas, "reasoning about particulars, combine and divide". The faculty differs from its equivalent in animals in relying on higher order cognition and experience instead of instinct.[42] Higher and lower reason in the intellectual soul are not distinct, they are only aimed at different ends. Higher reason aims at eternal things while lower reason at temporal.[43] Similarly practical and speculative intellects are not distinct, they differ in their ends. Speculative intellect apprehends to the consideration of truth, practical intellect aims at operations.[44] By operation Aquinas meant primarily scientific activity, but it cannot be denied that working with hand and a tool is also an operation, not necessarily involving universal ideas but still directed towards temporal aim. The boundary between the cogitative power and the lower reason or practical intellect is not at all clear. One argument St. Thomas presented against subsistence of the soul is particularly powerful: The intellect cannot understand without the body, since "the act of understanding does not

take place without a phantasm, which cannot exist apart from the body".[45] Despite his attempts to answer it is difficult to accept the final judgment of subsistence, for it is unclear how exactly knowledge of pure universals would look like and whether it is possible at all. Hence to treat the intellective faculty as different in degree is a justified modification for present purposes.

Cephalopods in general and octopuses in particular could possess even advanced mental faculties, the *vis cogitativa* or particular reason of the scholastics. Not too many people would argue for the case of octopuses with intellective faculty. Nevertheless if the differences of sensitive and intellective faculties are of degree only the case is far from clear.

Conclusion

Examined with the help of scholastic framework, some aspects of cephalopod behavior, sense perception and life cycle makes them more suitable to become intelligent species than humans. On the other hand, the fact tells more about the framework than about the examined subject, perhaps a common shortcoming of any framework attempting to examine mental states. At least the modified Aristotelian-scholastic model avoids the pitfalls of a totally anthropocentric framework. Even if medieval cosmology was closed in a sense to deny the existence of other worlds beside the very limited geocentric universe, their psychology was rather open. The scholastics created a very advanced theory of mind, even if their knowledge of animal behavior and biology was not of a high standard.

From modified scholastic point of view it is reasonable to suppose that cephalopods (and certainly higher vertebrates) have complex mental processes, some even particular reason. This, in turn, provides them with evolutionary potential for development of mental capacities. Unfortunately, by changing the framework, the conclusion may change radically and different theories may allow different degree of consciousness to animals. It is justified to ask whether we possess a proper framework to discuss consciousness. Could any other philosophy function adequately if sufficiently modified? Was Skinner right after

all in claiming that theories about consciousness did not advance significantly during their almost 3000 year history[46]?

Humans usually recognize each other as intelligent animals without any theoretical framework. As we move away from our own Umwelt, it is increasingly difficult to pinpoint in other animals the same things we take for granted in ourselves. Cephalopods have significantly different Umwelts than humans. Their sense perceptions are different, their life cycle, their "social" structure. These problems are more than relevant in scientific search for extraterrestrial intelligence, but also in matters pertaining to animal welfare/ animal rights and a generally acceptable philosophy would make things simpler.

As for the framework itself, after relatively minor modifications, scholastic psychology seems very much suitable for analyzing cognition and mental processes of even so different animals as cephalopods. We can offer several explanations why this is so, refraining from final judgment. There might be a grain of truth in every of them. First, it is possible that scholastic psychology has an absolute advantage over other philosophical explanations because it does not mention consciousness at all. It well may be, that problems in the philosophy of consciousness are only malignant legacy of Descartes and his "revolutionary" method, not least the introduction of the word consciousness in more or less modern sense. The scholastic model got along for centuries without the concept and it was still able to distinguish perfectly clearly between rational and not rational creatures without doubting even for a moment that animals have mental processes. Much of recent discussion is about qualia and most of the discussion is really hair splitting. Medieval philosophers (and they were accused by moderns for hair splitting) had no need for similar debate, since they had a working theory to explain what is going on in the souls of living beings. Needles to remind, much of sensation and cognition was explained in a way we would call today physicalism.

Second, we may be unknowingly the victims of biology, medicine and related sciences. Although these fields offer genuine scientific explanations, real philosophy cannot be based on neurophysiology or biology. A philosophical

theory of how living beings sense and process the information must be universal, must apply to living being in general. Scholastic psychology offers coherent explanation regardless of the substratum. Whether an animal is carbon based, silicon based or made of pure plasma is irrelevant, for the faculties of the soul will remain the same. It is even irrelevant whether the mental depend on matter or structure, the stumbling block of artificial intelligence[47], since the working of *anima* will be applicable in either case. This is not to deny that mental processes have no evolutionary significance, only to point out the necessity of universal theory if we wish to talk philosophy.

Third, the whole consciousness may be an illusion, a phantom imagined and more or less any theory that leaves the concept out is bound to be more successful than one using the concept. The only problem then, is to determine whether consciousness is really an illusion or it is an illusion of an illusion (ad infinitum), not an easy task.

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