Chapter 23 – The Missing Links Between Computer and Human Languages: Animal Cognition and Robotics

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Abstract

This chapter will consider animal cognition in the context of linguistics and robotics. Building off of themes introduced in Chapter 20, we explore possible models for intermediate-level languages which are more lifelike and situationally grounded than formal computer code, but less complex and nuanced than natural (human) language. Studying language at this "intermediate" level — in contexts where we can identify shared situational models between conversing agents, but wherein the surface-forms of language do not necessarily take on the burden of syntactic conformance and thorough linguistic encoding of propositional content — may yield insights into how best to design discursive systems for Human-Robot Interaction (HRI). In this chapter we address these themes by investigating how "animal language" can provide a model for intermediate languages in this sense. We focus on observations and data generated in the context of research on human-canine interactions in the specific modality where people train dogs to use "talking buttons", inspired by Augmentative and Alternative Communication (AAC) devices designed to help speech-language pathologists and their patients, such as children on the autism spectrum. We explore how a few dogs have achieved surprising levels of communicative sophistication — which is not to imply that they "talk" in human language, but they do reveal situational and intersubjective/collaborative awareness that potentially goes beyond dogs' reasoning abilities as measured by even very recent dog-cognition research. We conclude by assessing how such observations point toward a general theory of language at an intermediate stage which may have applications to robotics.

1 Introduction

Chapter 20 began with a review of the differences between natural and programming languages, and this chapter, as well the next, will explore such differences (and a few similarities) in greater depth. These chapters will also consider human/robot communication as a case-study in forms of language that may be intermediary between human language (in all its complexity and nuance) and the mechanistic, artificial limits of computer code. Once we step beyond communication between *people*, what should we understand by "language" specifically; what significance should be attached to calling a sign-system *language* and not something more general (some less-specific form of iconification or symbolic representation)?

To explore such questions, it is interesting to consider other examples of language/communication — apart from both programming and natural/human languages. Hence robotics, looking ahead to Chapter 24. Our idea in *this* chapter is to approach these topics from the perspective of "animal cognition": that is, to consider whether communication between non-human animals, or (especially) between people and animals, can offer insights onto forms of discourse which are simpler than human speech but also, unlike computer code, organically evolving (not artificially manufactured) and inter-personal, emerging in the context of animals' social lives and interactions.

Examining "non-human" languages — from computers to animals — has several different practical and theoretical payoffs. On the one hand, analyzing simpler modes of communication can shed light on human language, which is arguably the most complex discursive framework we know of; its origins, formal mechanisms, and cognitive foundations. On the other hand, simpler sign-systems might serve as models for constructed computer/robot languages more so than natural human speech proper — unless we intend to equip robots with full-fledged NLP engines (which could run up against limits in how thoroughly Natural Language Processing may ever fully comprehend human dialog) [14], [11], [20], [40]. If we envision people "talking to" robots, for instance, accuracy depends both on correct speech recognition (e.g., speech-to-text conversion) and then correct parsing of generated text. Even theoretically strong results, such as an engine achieving accuracy over 90%, could yield an interface that people still experience as hard to use — it would be frustrating to conduct a conversation with a partner who misunderstands one out of every 10 words.

Moreover, even if engineers overcome or just accept such barriers, it is hard to envision a scenario where an NLP interface should be the *primary* means of communicating with robots or computers. Presumably natural-language inputs would be parsed into intermediate structures reflecting a more computationally tractable language, and for testing or development — plus as an alternative interface that users might find more convenient — presumably robots and software should be equipped to accept inputs in "languages" structured around computers' innate instructions and capabilities.

The prior chapters in this section have focused on Virtual Machines, in contexts such as cross-component interop protocols and image-processing. Virtual Machines are intrinsic to the implementation of "computer" languages because they may serve as an execution engine for bytecode derived from parsing programming-language expressions into machine-readable intermediate representations. Looking ahead, Chapter 24 will address more practical issues in deploying languages within robotics, for example. This chapter therefore serves as a kind of bridge or interregnum. If we intend to design languages for robots, and other *en situ* installed computing environments — and moreover we feel a need to find communication models other than human language

as guides or prototypes — it is worth examining whether language-use by non-human animals carries potential lessons for discourse engineered as a computational capability.

Most animal-communication research has focused on how animals express or coordinate thoughts with one another (in the same species), and scientists have developed ingenious methods to measure the sophistication and infer the meaning of animals' vocalizations (see for instance [43, e.g., pages 24 and 30]). While this is important, equally valid insights can be gleaned from watching animals such as dogs and gorillas learn to speak *our* language, whether through signs/gesture or through programming devices that produce words as if one were "talking." Because they are already pets, studying dog cognition is logistically simpler than with most other animals. This century has seen a noteworthy uptick in studies focusing on dogs' reasoning and neural architecture, such as Gregory Berns's "Dog Project" — obtaining the first Functional MRI imaging of dogs in a fully alert and engaged state, allowing their patterns of brain-activation while playing certain games and interacting with their caregivers to be imaged and analyzed [3]. More recently, several dog owners have conducted what are in effect "citizen science" projects where they train their pets to "talk" via Augmentative and Alternative Communication (AAC) buttons. Their published videos suggest that dogs, after adapting to AAC devices, are capable of linguistically interacting with people on a non-trivial level, forming compound sentences and grasping the epistemic and interpersonal dimensions of human speech (e.g., using language to convey new information to someone, or comment on present situations).

Such observations paint a preliminary but compelling picture of the level of linguistic understanding that dogs can attain. We will argue that language at this level offers a plausible model of "mid-level" language systems that are richer than computer code but still more rudimentary and tractable than human language itself (as practiced between fully-competent speakers, in the context of collective human activities or situations).

The primary sources we will analyze here are reports published by Christina Hunger, a speech therapist who works professionally with young children, about her experiences when she encouraged her dog Stella to communicate using AAC buttons (allowing dogs to produce word-sounds by stepping on the buttons with their paws). Inspired by Stella's progress, "talking dogs" has become something of an internet meme over the last few years.[1] Following Stella, a Sheepadoodle named Bunny, and her caregiver, Alexis Devine, has developed a wide social media following. A data set accompanying this chapter includes links to hundreds of videos featuring these two dogs, along with summarial annotations and computer code (such as procedures implemented to locate their video links). There is growing data supporting the notion that dogs have cognitive faculties that with some learning can be manifest in a surprisingly sophisticated level of language-like communication, albeit through the use of mechanical speech-aids as intermediaries.

The point is not that dogs conduct conversations on even a child's level, but the level of understanding they do possess is noteworthy — especially when we consider that they are not evolved to vocalize words, and have to adjust to mechanical artifacts to communicate with humans on our own terms (adding a layer of complexity to the whole process that would not be evident in, let's say, bird songs or Chimpanzee calls). How dogs nonetheless adapt to human language, we will argue, presents some interesting insights on the nature of human language itself — and, by extension, on how some properties of human languages can be simulated in more primitive contexts, such as robots' communication.

[1] Needless to say, this has nothing to do with cute videos of dogs (especially Huskies) barking or howling in ways that with some imagination we might perceive as trying to produce human words. Analysis of innate canine calls is a legitimate scientific topic, but at best only tangential to the new AAC-inspired research.

1.1 Comments on Methodology

Animal cognition, robotics, and even computer science lie at an interesting intermediary position within the spectrum of scientific or academic disciplines. The emergence of computers, "digital humanities," Artificial Intelligence (and related research areas), computational linguistics, and so forth, have all added to the scope of hybrid disciplines that in various ways straddle humanistic and physical sciences.[2] Methodologies here can run the gamut from quantitative models similar to those of chemistry or physics — consider brain scans or Artificial Neural Networks — to interpretive projects descended from philosophical schools such as Phenomenology, or the kind of multidisciplinary "humanities theory" associated with (for example) Gender Studies or Criticial Race Theory.

Instead of ranking methodological paradigms as "more" or "less" scientific (or rigorous, unbiased, etc.) hybrid disciplines suggest how different research protocols address similar topics from different directions. For example, macroeconomic analyses (often based on quantitative models) work with empirical data, but they average over large aggregates of individual economic choices. On the other hand, phychological and/or neurological research into economic decision-making (e.g., Gregory Berns's work prior to his branching into dog cognition) centers on each individuals' thought processes. The two perspectives are complementary. From a different angle, *socio*economic research can address how economic systems overlap with other social structures. Each approach has its own sense of "empirical" data, which might be economic data sets, brain scans, or sociological case studies. In contrast to natural sciences, where there are certain core paradigms — typically, mathematical models justified by experiments and/or observations — to the extent that research projects are neither purely "scientific" nor "humanistic" it becomes harder to privilege one evidentiary protocol or theory of argumentation over others. Warrants for researchers' claims have to be evaluated on a case-by-case basis.

Linguistics, in particular, illustrates the expanse of science/humanities hybrids in microcosm. Human languages have both fairly rigorous rule-structures and nondeterministic interpretive nuance. Analyzing the former structural realm permits quasimathematical formal models, while delving into the latter calls on forms of theory grounded in conceptual precision rather than empirical or computational observations (consider how Cognitive Linguistics implicitly justifies treatment of sentences' epistemic status or parse-structures based on collective/introspective assent — authors and their readers mutually agreeing that certain reconstructions of cognitive processing appear to be plausible given our innate sense of how *we* understand language). Meanwhile, although programming languages are not "interpretive" — compiler theory and runtime engineering are governed by the mechanistic limitations of CPU (or other processing) architectures — some facets of software engineering, such as optimal design patterns and Human-Comptuer Interaction, are more subjective.

[2] In "academia" — e.g., university departments, journal foci, book classification — one implicitly recognizes a baseline distinction between humanities and physical sciences. A lot of research, however, does not fit neatly into either category. Traditionally of course we have a notion of "social" sciences, which tend to overlap with humanities disciplines in terms of subject matter but with "natural" sciences in terms of methodology. This has been, perhaps, a tenuous admixture for generations. This is all the more true the more that humanistic and social sciences become influenced by computers and technology.

Animal-cognition and ethology spans multiple forms of empirical data, including reasoning experiments (involving manufactured problem-solving scenarios) and fMRI scans, as well as (less carefully-staged) observations of animal behavior. With respect to animal *language*, even in the nascent "talking dog" community there is already a nontrivial amount of empirical data, and projects such as TheyCanTalk at the University of California at San Diego promise much more. This data immediately raises questions of where to fit analytic methodology on the science/humanities continuum, and how "dog language" should be situated in its hybrid intellectual space.

Dog-cognition research and interpretations thereof may lead in multiple directions: there is a psychological/experimental stratum of controlled studies exploring canine reasoning; a linguistic interest in dogs' behaviors in contexts related to human language; the ethology of canine adaptation to human environments through domestication; and even an anthropological perspective drawing insights from dogs' "pro-social" comportments to speculate about human history and society (encapsulated by the title and phrase coined by Brian Hare and Vanessa Woods, "Survival of the Friendliest" [18]). Given this thematic range, we can expect that a comprehensive picture of dog cognition — and what it means for humans — can only be pieced together with bricks that reveal a spectrum of topical foci and academic styles. This is not a discipline that should rely on facile argumentational templates as landmarks for methodological gravitas. Or, in other words, dog-cognition reveals multiple metatheoretic personalities no less than any other human/social science, from paper to paper (or even paragraph to paragraph). By analogy, queer theorists' subaltern dialectology, phenomenological introspections into cognitive-schematic acceptability, and Category-Theoretic proofs of the Chomsky-Schützenberger Representation Theorem are all sibling projects in the linguist's ecosystem.[3]

As a subset of dog-cognition investigations, if we consider communication via AAC devices — as opposed to dogs such as Chaser or Rico (border collies famous for large vocabularies) *responding to* rather than *generating* speech-acts, as per John Pilley's or Juliane Kaminski's (their respective owners) methods [37], [24], [25] (and likewise, influentially, Stanley Coren [9, Chapter 6]) — this is a very recent trend, and little academic work addresses this subject directly (we have yet to see the peer-review dialectics and methodological back-and-forth that might guide research in how best to formulate theories and hypotheses). Nonetheless, internet discussions reveal a lively exchange of claims and counterclaims about "talking" dogs, such that the parameters of future academic protocols are perhaps already visible.

Perhaps the most substantial debates have centered on the question of "over-interpretation," an implication that observers "read too much" into dogs' use of talking buttons. This is not, indeed, a subject-area that is conducive to neutral observation — ethology (the study of animal behavior) probably tends to attract animal lovers, and documenting animal intelligence and emotions is doubtless an important step toward promoting animal welfare and humane treatment. Such a scenario risks confirmation bias for people who *want* to find evidence of (for example) canine intelligence and the dog/human emotional bond.

The proper response to issues of over-interpretation is to adopt protocols which can mitigate its deleterious effects, without eliding how *some level* of interpretation is patently appropriate. Dogs, obviously, are not "fluent" in human language, and their attempts to communicate with us via our own mechanisms — (arguably) innate for us, not them — are inevitably provisional and trial-and-error based, comparable to human toddlers (not to imply that dogs have a similar level of linguistic proficiency, but just that their use of language can be more confident in one situation and less in another, similar to that of young children). Also, dogs' communication via AAC boards is restricted to the set of buttons (typically less than one hundred) that boards provide. Sometimes dogs have to guess at the meaning of words — i.e., at what *humans* will think upon hearing them. This is a natural part of *learning* language.

In and of itself, then, *interpreting* dogs' communications is not unwarranted. When Bunny, for example, sounds out "ouch stranger paw" because she has a thorn embedded between her toes, we must indeed "interpret" this phrase, but it is situation-specific and reasonable to the point where we can assert with some confidence that she chose those specific words intentionally (i.e., *linguistically*). Other interpretations might be more tenuous. Bunny appears curious about time: "soon afternoon," "night yesterday," "yesterday went"[4] — and about, say, the concepts of "human" and "animals." Her asking broad (even "philosophical" questions) via AAC buttons is an intriguing behavior, but also one we should hesitate to extrapolate equally to more situationally grounded episodes.

We would argue that an optimal methodology would accept interpretations but also introduce a series of metrics framing the degree of guesswork or confidence such interpretations reveal. For example, any given video-segment showing dogs' button-use might be annotated with parameters such as their "deliberateness" — whether the dogs seem to press buttons in a premeditated fashion, anticipating a specific set of buttons, and reacting only *after* a total phrase is enunciated before seeking a response. We could also measure the degree of confidence we as human observers have in our interpretations — are we guessing at what the dog might be saying — and at the communiqué's situation appropriateness. Also — consider Hunger's distinction between "core" and "frings" vocabulary programmed into AAC boards [21, page 97] — seemingly well-motivated phrases involving less-common words would serve as stronger data for something like bonafide linguistic understanding than capably employing baseline words such as "outside" or "play."

Moreover, we can check how the dogs' *other* (non-AAC) behaviors coincide resonate with interpretations of their "talking." Saying something about going outside and then walking to the door is a strong confirmation that sounding "outside" is proficient and deliberate (the dog is not just guessing about what *that* word means). Likewise, Bunny jumping on a sofa and showing her paw after the "ouch stranger" phrase — or, in another video, her expressing "want cat" and then looking in the direction of her feline housemate; or Stella saying "friend" before kissing her (human) baby brother — are behaviors that would be puzzling if the dogs were *not* using buttons situationally.

Actually watching Stella and Bunny videos, it does appear that many times their choice of buttons is deliberate and premeditated. Sometimes the results are enigmatic, and it is reasonable on such occasions for the scientifically-minded to question how well they actually understand words they produce. But even if dogs fail to grok the nuances of humans' construals and semantic encodings of abstract concepts, the fact that they show interest in words for these concepts — and *attempt* to incorporate them — reveals a basic understanding of the underlying linguistic principle that words (sound-gestures)

[3] We'll cite [33], repeated from Chapter 21.

[4] See https://www.google.com/search?q=Bunny%E2%80%99s+newest+video%2C+%E2%80%9CContemplating+Time\#fpstate=ive&vld=cid:1b0acd07,vid:echpdOTH78w — this video certainly seems to show Bunny's person "teaching" her time-words and concepts, and Bunny "learning" interrelationships between these concepts.

designate "objects," sometimes including abstract concepts.

Moreover, often it seems their discourse is haphazard and uncertain — probably dogs do not rise to a level of linguistic competence we associate with young humans, at the time when children begin to internalize principles of grammar and produce complete sentences ([38, page 269], for instance). But so what? These points, even if eventually borne out by empirical data, would only refute claims that dogs progress through language-learning as rapidly and extensively as human beings. There is still a large terrain of linguistic understanding and pre-linguistic awareness that lies anterior to formal grammar, but building off of generic "gestural" communication toward bonafide language-use, via words as convention-driven icons for generalized concepts and via linguistic expressions as media for exchange of ideas.

If we find *Cognitive* linguistics, in particular, an especially compelling approach to structure and processing, it is actually very interesting to witness a stratum of cognition which lies within the threshold of language proper but is also organized by intuitive cross-conceptual patterns rather than under the influence of syntactic regularities, gradually internalized. Treating grammar as a formal chisel that molds provisional linguistic awareness into structured human language, to glimpse that awareness in its "raw" or primordial mentality, prior to the dictates of syntactic form, is a valuable opportunity. This is especially true for projects oriented around "languages" outside human contexts proper, such as robots. Equally, we should acknowledge that linguistic understanding *without* syntactic entrenchment still reveals high-level cognitive acuity, perhaps reflecting dogs' highly evolved ability to "read" humans.

Methodologically, even within the recent "dognition" research trend, studies of dogs' reasoning has been oriented to artificially-manufactured experiments are not necessarily proper assessments of canine cognition in their everyday lives. Most of this research apparently follows protocols of experimental psychology typically applied to humans (including other children) or to animals in controlled habitats, not household pets. Obviously this situation reflects logistical problems in obtaining empirical data in non-controlled settings. Against this backdrop, however, dogs' use of AAC buttons is an intriguing alternative. Such buttons may be deployed in their familiar domestic environments, and with some training (which some dogs appear to enjoy) can become part of their daily lives. At the same time, what dogs choose to enunciate through AAC boards, and their behaviors while doing so, indirectly suggests properties of their cognitive states.

This may be indirect evidence, requiring inferential reasoning to fill out, but no less so, we would argue, than extrapolating from psychological metrics in artificial setups. The evidentiary frameworks for dog-language assessments belong more to Cognitive Linguistics than Cognitive Psychology, and therefore bring on board a suite of theories from an alternative and complementary perspective. For these sorts of reasons, extant "talking dog" data should be approached as an important scientific resource. We believe this is how we should read testimonies such as *How Stella Learned to Talk*.

2 Animal Cognition and Talking Dogs

Anyone who has cared for a dog understands that they are highly communicative, and can understand a lot of human language by hearing, even if they do not natively "talk" themselves. It is not surprising, with this in mind, that dogs can extrapolate from *hearing* human speech, as well as from their own ways of communicating with people (because dogs are certainly capable of letting caregivers know what they want) — learning to use "talking buttons" as an extra medium on top of all their existing communicative toolkit. Reading "talking dog" accounts one might be inclined to expect dogs' language to essentially grow out of their gestural/expressive repertoire in its familiar form. Case studies such as Christina Hunger's dog Stella, however, suggest a more complex language-development process. We contend that for this reason these case-studies deserve particular attention in the general area of linguistics and philosophy of language.

When assessing dogs' communicative instincts vis-à-vis their human companions, we should also bear in mind how there is a "dialogic" element even to purely non-linguistic interactions. Consider two people intending to lift a heavy piece of furniture: it is not unusual in these cases for us to exaggerate gestures to some extent, using eye-contact and nonverbal cues to coordinate our actions. The goal of course is for both people to lift at the same time, and we instinctively try to ensure such coordination by enacting the relevant physical routine (bending our knees, positioning our arms) conscious of the other person watching and timing their similar actions to match ours. These gestures therefore migrate from being elementary motions to achieve some physical task to being expressive signs at some level, analogous to how a person standing up from a chair often signals their intention to leave the table, or how a host extending a bottle of wine to a guest serves as an invitation for the latter to extend their glass in turn for a reup. Dogs of course signify through gestures in similar ways; standing by the door in a posture which makes it convenient to attach their leash is an unambiguous way for a dog to prompt their caregiver for a walk.

Given that certain physical movements are recurring tropes when carrying out some repeated task — and that people (plus animals too) see one another performing such movements and can often infer their goals — movements in and of themselves are sometimes a way to make another person aware of one's own desire or intention. Acting out gestures typical of *starting* some enactive sequence is, in particular, a prompt to solicit another's attention to complete the task collaboratively; holding out a bottle is the first in a multi-step process which ends (presumably) in a glass being filled. We can't really say that the holding-out is a physical gesture with no expressive intent, but nor is it a pure sign; in a sense it hovers between being a nonverbal signifier and an actual attempt to initiate a pragmatic sequence. The very fact that people coexist in co-enactive and co-visible worlds means that almost any enactive gesture, insofar as it is witnessed by others, could potentially become also a dialogic sign, especially if there are ways for the initiator's actions to be continued with physical participation from another person.

It is reasonable to speculate that language itself emerges from these prelinguistic cues. Such gestures as holding out a bottle, or deliberately practicing how one should grasp a piece of furniture, can be performed without a conscious awareness of producing a signifier of one's intentions; but as soon as we realize that another person observing our actions could potentially respond to them interactively, we inevitably will become disposed to construe our gestures as communicative devices as well as pragmatic mini-steps. It is not hard to see how such dialogic awareness can progress to the point where we perform gestures *primarily* for their communicative effects. Consider a person holding an elevator door for someone else a few steps away — this is often done in such a way as to show the fellow-rider how the doors are being deliberately obstructed, perhaps inviting them to clarify whether they

are in fact trying to catch up to the elevator. People will perform such a gesture even if putting one's arms over the door does not actually work to keep them open (we might use our free hand to press a button instead) — the movements to prevent the doors from closing then serve as a communicative signal more than a pragmatic act, although we may not consciously register the difference.

The point here is that we do not necessarily choose between carrying out gestures for their dialogic impact or their pragmatic effects, or even explicitly deliberate on how much an act may be communicative versus enactive — instead, we instinctively perform gestures which have some mixture of practical and discursive content and allow the admixture between the two to evolve organically. In the "elevator" example, if we realize that we need to press a button and cannot force the doors open just with our arms, we would still maintain the door-blocking gesture to signify that others can board the elevator if desired, so in that scenario the gesture migrates to being mostly dialogic and not pragmatic; but conversely the elevator might have a sensor which reopens the doors on resistance, so the same gesture in that case would be pragmatic as much as significatory. We may not know how the episode will play out *a priori*, and, in effect, have learned just by recurring interactions with other people how to act collaboratively and allow for nonverbal gestures to mutate back and forth between communication and enaction, recalibrating our intentions accordingly.

Given recent "talking dog" evidence it seems that dogs essentially do the same thing, and are able to transition from performing gestures instinctively to self-consciously soliciting people to observe what they are doing so as to convey some idea. A dog will walk to the door when they want to go outside, look you in the eye when they want to share your food, or position themselves by a water dish when they are thirsty. In *How Stella Learned to Talk*, Hunger describes how Stella as a puppy, a day or two after being adopted, pawed at her water dish requesting that Christina fill it up (we will use first names when warranted because those names eventually became part of Stella's vocabulary, per Hunger's account). Of course, a dog might use her paws to move their water dish so it is easier to drink, but Stella obviously was aware that having Christina see her doing this might alert the person of her need for water *in* the dish.

In the context of "gestural" communication, moreover, we should also bear in mind how dogs (and, presumably, most or all other animals) have evolved in the context of a natural world in which almost all actions involve physical *inter*-actions with other objects. To lift a tree-branch which is partly entwined on roots you need to tug at it until the force you import disentangles the branch from its surroundings; to unearth something underground you need to dig a hole by displacing soil with your paws. Force and causality in these situations are clearly localized and experienced directly through your physical movements — pulling a branch with your mouth, carving the ground with your paws. This force-dynamic reality is a natural conduit for gestures being eventually metastatized to signs, once we become aware that someone else can *see* us pulling or pawing, and maybe infer what we are trying to do.[5] As such dogs can instinctively translate their enactive cognition to gestural dialog, as with pawing at a water dish or walking to the door to go outside.

At the same time, however, dogs in a (in many ways un-natural) human environment also adapt to a world which can be counter-intuitive against force-dynamic instincts. As humans we may forget how we have become habituated to environments where our enactive patterns have apparent causal anomalies: we hit a switch on a wall and a light comes on across the room. We pull a sink faucet handle to the right and water comes out of a pipe some 10-12 inches away from where our hand-gesture took place. For an animal evolved for a world without such engineered artifacts, making sense of when such "leaps" of causation across space happen — and when they don't — understandably takes some time and watchfulness. Dogs have to figure out that (say) people can get water by pressing a button, but have to manually open the door of a refrigerator or cupboard to get food.

Nevertheless, once dogs start to realize that cause-and-effect in the human world does not always follow localized force-dynamic patterns, this possibility seems to open up more expansive linguistic potential. Consider Hunger's account of her initial experiments involving Stella's "talk" buttons. As she describes it, she placed an "outside" button near the door, a "water" button near Stella's water dish, and "play" by her toys. If we imagine ourselves in her (Stella's) shoes, it is reasonable to guess that at first (she being just a few-month-old puppy) the buttons were not experienced as *communicative* devices per se. Indeed, evidently it took a little over two weeks for her to pay them much attention. But recall our earlier comments about water coming from a faucet upon turning a handle — a dog would surely realize that humans have, in some sense, rigged up systems where water becomes available somewhat mysteriously, compared to out in nature where one would, let's say, walk over to a stream to drink. So eventually Stella evidently figured out that the button which produced the sound of the word "water" had something to do with her people putting water in her dish (Christina and Jake, her other caregiver, also said the word "water" often so that she would have been familiar with its sound).

Given that Hunger describes Stella's acclimation to her buttons as slow at first, we can certainly hypothesize that Stella only gradually came to understand their purpose as being communicative — after all, if people could press a switch for light, why not press a button for water? True, she also adapted to the "outside" button to signal when she wanted to take a walk, and there's no obvious corollary to the relation of a faucet-handle to running water that could serve as an analogy to a water-button in the context of going outside. But humans have their own routines when going outside — they grab keys, put on jackets, and so forth — so we can imagine Stella guessing that maybe the button served some functional purpose, analogous to how someone might remotely unlock a car door. If we grab our keys, it signals to a dog we're probably going out; they will then associate the keys with outside, even if they may not understand why the keys have an operational purpose. For all Stella knows (at that early stage) the "outside" button might have been functional in the same way — but, still, on the theory that initiating pragmatic sequences is a way of conveying wishes, functional devices can be pressed into service for dialogic ends.

In effect, we can guess at her reasoning: if humans have this thing where they press a black button to go outside, maybe I can prompt them to go outside by doing the same, hoping this initiates the rest of the process? As Hunger put it, describing one of the first occasions when Stella seemed to notice her buttons,

> There was no way for me to know Stella's intention as she stood in front of the buzzer and looking down at it. She might have wanted to get my attention to go outside, or she might have simply been curious about the object on the floor. Either way, I did not care. Providing positive praise showed Stella that I enjoyed what she was doing, which would hopefully lead her to continue exploring the buttons in the

[5] Indeed, recent dog-cognition research strongly suggests that dogs learn by observing other dogs, perhaps even to a degree more often associated with higher primates.

future. (*How Stella Learned to Talk*, page 59).

By now she evidently realized that the button had something to do with going outside, so she may have reasoned that Christina seeing her paying attention to the button would be a way to suggest her interest in doing just that. Or she may have been trying to figure out *why* or *how* the button factored in to the going-outside process. Huger writes about Jake's noticing Stella "barking" at the outside-button and wagging her tail when Jake pressed it, behaviors suggesting that Stella at first interpreted the button as operationally part of going outside, not realizing that *she* could press the button too, which we can imagine would take a further paradigm shift — after all, she didn't grab the keys, open the door, or any of the other details of going-outside that the humans performed. "Stella looked down at the buzzer, then up at me, and back down to her "outside" button. This time, there was no questioning her eye gaze. She was gesturing for me to push it" [page 61].[6] Hunger reports that over time Stella's awareness of the buttons was initially focused on her watching *people* press them, in the midst of all their other goings-on; she did not at first grasp upon the buttons as something for Stella *herself* to use [page 67].

Retracing Stella's thoughts is purely speculative on our part, of course, but our point is that we can see the origins of linguistic communication in non-linguistic circumstances. Even if we accept the notion that language is an "innate" human ability, and that some preconfigured intellectual faculty is a precondition for possessing language on a full human level, observing cases such as Stella's acclimation to her "water" and "outside" buttons gives us intuitive feedback that animals *without* innate linguistic faculties (in the sense of actual human language) can nevertheless acquire the foundations of language by branching off of other cognitive modalities that *are* innate (to them).

In short, at some point Stella must have realized that the point of the buttons was to mimic the words that Jake and Christina say to each other (and to Stella herself) rather than some other functional role like the faucet-handle vis-à-vis the faucet or the keys to the door. That is, the buttons are not causally efficacious (even in the indirect engineered way that things sometimes happen in the human world, at least the modern human world of electricity and running water); their sole effect is to trigger other people's understanding. Stella learned to say "water" to achieve the effect of Jake or Christina becoming aware that she was thirsty (and maybe needed water in the dish). Obviously this understanding of communicative effects piggybacks on a dog's acute awareness of their people's thoughts and feelings. Stella presumably sought to express her need for water to Christina because she believed that (1) Christina did not know she needed water and (2) Christina would make sure to give Stella water if she sees the empty dish.

Even in this still-rudimentary use of "language" — or, at least, single words — we can see some of the foundations of language as a human phenomenon. Not surprisingly, dogs' communication often reflects their wants and desires, and (as we alluded to at the start of this section) we might guess that dogs use "talking buttons" as basically an extension of all their other communicative gestures. If a dog instinctively (and surely self-consciously) acts theatrically cute-sweet and charming when she wants a treat, it's not hard to imagine similar instincts guiding them to solicit our attention by stepping on a button when they want water. But reviewing the evolution of Stella's linguistic abilities suggests that more was involved, as her use of talk-buttons expanded, than the kind of emotional-solicitous gestures that dogs often perform when they want something.

In particular, Stella's use of the buttons was clearly grounded on a seemingly advanced capacity to infer what the people around her knew and intended. Obviously some level of mind-reading is also implicit in, let's say, "solicitous" performances — a dog might realize how acting affectionate to a person will cause the person to mirror that affection toward the dog in turn, hopefully scoring a treat or an ear-scratch. That kind of mind-reading is emotionally charged and has a certain lap-dog tactility. What is interesting about dogs like Stella (and, say, Bunny) is that their ability to co-ordinate with human's epistemic states is equally evident even when taken outside the tactile contexts that presumably evolved as dogs became domesticated — in effect, the evidence is that dogs read people's minds beyond their presumably instinctive awareness of how affection and tactile interactions can promote dog-human bonding.

By way of example, one interesting anecdote Hunger describes, moving forward a few months in Stella's development, concerned an occasion when Stella and Christina had returned from a walk. Once Stella realized that her talk-buttons were not simply gadgets for humans to use — Jake and Christina encouraged *her* to press them — Stella picked up on their communicative purpose quickly. (Hunger suggests that only a day or two after she first used the "outside" button herself to go out in the yard, she also pressed her "play" button — after Christina had done so too when Stella went over to her toy bin — to signal that now she wanted to play inside. In effect, she immediately generalized from the "outside" button to the "play" button.) Hunger gradually expanded the number of buttons with programmed words, and eventually decided to group the buttons together on a board (rather than positioning the buttons thematically: the "water" button by the water dish, and so forth). Having the buttons in one place made it easier for Stella to use two or more buttons to create phrases. Hunger's account of Stella gradually forming increasingly complex and detailed expressions include numerous examples that are interesting from a linguistic point of view. We will mention in particular several examples that touch on Stella's (so to speak) "epistemic" awareness.

The incident we started to mention last paragraph (the family had moved to San Diego in the interim) happened on a day when Christina and Stella went to a dog park; Jake was not at home when they left, but had returned by the time they returned. Seeing him, Stella used her buttons to say the two-word phrase "park play," and a likely interpretation is that Stella wanted to clarify for his sake where the other two members of the family had gone [page 198] (contrast with [23]). The day before, they had all gone to another favorite spot, by the ocean (programmed as the "beach" on another button) — beforehand Stella was apparently impatient waiting for the humans to finish eating before they could leave; upon returning, Stella "said" (via the buttons) "bye Stella bye good outside": "She was using her words to comment on what she just did, not what was happening now or what she wanted." [page 198] (She had figured out to use the "bye" button as a proxy for "leave"). Similarly, somewhat before then, "Jake woke up earlier than usual [and] took Stella on a much longer walk than they normally took before work" [page 179] and upon their return she said with her buttons "good Jake" (perhaps expressing to him that she liked to walk or to Christina about their morning, or both).

Two-word pairs like "park play" and "good Jake" were actually simpler than a lot of Stella's word-use by this time, but these three occasions are noteworthy, we believe, because they all involve her commenting on activities that were completed, and so they could not be read as her merely translating her instincts for goal-seeking

[6] Future page references without further citations will refer to *How Stella Learned to Talk*.

communication to the talking-button arrangement. Stella seemed to be pursuing dialog for its own sake, not as a means to some immediate end. Moreover, at least part of her intent appears to be describing things that have recently transpired to the third party — telling Jake that she and Christina had played in the park, or telling Christina that she was happy with Jake for a long walk. Such conversations indirectly reveal Stella's implicit understanding of "belief formation" — an awareness, for example, that Jake returning for work after the rest of the family had left would not know where they went. Stella was (quite possibly) using language to fill in gaps in (what she accurately assessed as) belief-states of other people, at her own initiation, a level of linguistic maturity that would be impressive coming from a human toddler, let alone a one-year-old puppy.

Similar "epistemic" cognition is evidenced on other sorts of occasions. Hunger describes, for instance, how Stella once knocked something over unintentionally, then said "no" to explain that it was an accident — obviously she was worried Christina might *think* that her actions were deliberate [page 205]. Once when she wanted to go out early in the morning, her people still a little bleary-eyed, she heard Jake ask Christina to take her, to which Stella explicitly said "Jake" — that is, Stella inferred from their conversation their jointly forming an intention for her to do the honors and not him, inferring humans' planning and intentions [page 182]. A similar occasion involved Stella hearing the two debating whether to go out yet one more time, and — when they seemed to be inclined to retire for the night instead ("'I think we can stay in ... She's probably good'") — Stella proceeded to "hop off her bed" and say "mad outside come come outside," a reaction probably triggered by hearing their conversation (since she was resting at the time, it seems that she only explicitly requested to go out once she realized that they were inclined not to).

Another time, when their

> neighbors were dog sitting [and] Stella saw them walk past the window with an unfamiliar dog, she barked, said "help no help" and ran to the window to bark again. Stella recognized that our neighbors were bringing a stranger into our complex. She did not bark when they walked with their own dog into their unit. I wondered if Stella was using her words to tell us why she was barking [page 197].

At the very least she was clearly trying to alert her family about something suspicious. What's noteworthy is how she deliberately incorporated her talk-buttons, instead of just barking — she actually ran over to the buttons and used them, before returning to the window. Also, she acted as if aware that Christina, elsewhere in the house, could *not* see the dog. As with Jake coming home while they were at the park, Stella was logically aware of epistemic *absence*, of what someone would *not* know, and how language can fill in such gaps. Against this backdrop, it is worth noting that philosophers (even in recent times) have openly debated the question of how extensively animals possess a "theory of other minds" — an awareness of the structural patterns of belief-formation and the perspectival limits of knowledge. Even after it has become generally accepted that an animal's world can be richly social and experiential, philosophers and behavioral scientists have perhaps been conservative in attributing sophisticated awareness of what *other* animals believe — perhaps projecting from human development, since it takes some growth for children to show signs of grasping epistemic patterns intuitively.

Reading about multiple occasions where Stella — still a puppy and with only a few months' exposure to "talk buttons" — employs her buttons to communicative effect where understanding "other minds" is likely an explicit factor, Stella's incorporating this awareness into explicit conversations through talk-buttons, without human prompting, makes the breadth of her "theory of mind" especially concrete. The buttons add a new layer of specificity to how we might observe animal behavior. In particular, Stella's communications with her two caregivers are often implicitly three-way conversations where Stella distinguishes Jake's beliefs from Christina's. An operational theory of mind at this level, we can surely posit, reflects a qualitatively more sophisticated form of linguistic capability than a dog's use of communicative gestures to achieve specific goals, prompted by somatic (more than "cognitive") issues like thirst or hunger.

Another dimension to Stella's emerging language-use is how she evinces high-level conceptual understanding. In particular, she appears to generalize concepts to different contexts and situations. There are multiple examples in Hunger's account which could be cited in this context — for instance, very early at the stage where Stella had just started to use her buttons (not yet grouped onto a board), she was watching Christina water some plants, and used her button to *say* "water." Hunger reports her thinking first that Stella needed water in her dish, but then realized the dish was full — instead, Stella was *commenting* on how Christina was spraying water on the plants. It is interesting to begin with that Stella was using her button even outside the context of asking for something — again, this happened while the buttons were still new for her[7] — and also that she unhesitantly perceived the concept "water" as applying to the water Christina gave to the plants, poured from a can, just as it applied to her water dish (moreover she made this inference visually; she did not drink or touch the water for the plants).

After their move to San Diego, Hunger also describes when Stella's "beach" button broke, and they had to wait for a replacement. Wanting to go to the beach, she decided to use the combination "water outside" as a (de facto) "lexical" substitute for "beach" [page 213]. She actually said "mad" (after the button stopped working) and then "help water outside," having learned to sound "help" when something was wrong with her buttons.[8] Stella obviously understood that the beach was adjacent to the ocean, and that the ocean had water. In short, she generalized the concept "water" from what was in her dish to what was watering the plants to what was in the ocean.

Hunger documents similar generalizations with other words. For Stella, "outside" could function as a signifier for the "immediate" outside (e.g., their yard) or something further (e.g., the beach); she said "help" when she needed the people to fix or resolve something (like a toy inaccessible under the sofa) but also to add oomph to her requests. After a pair of rainy days, for instance, Hunger reports how Stella said "help beach love you" [page 168], evidently thinking she needed more entreating to get her humans' attention ("help" implying a need for attention beyond the typical level of interest she might have when just saying "beach" by itself).[9]

Stella also showed an appreciation for conceptual nuances that were not limited to physical things ("nouns," lexically speaking). She used "bye" like a verb, saying "Christina bye" one morning after she had left for work [page 180], or "bye" when they had dropped her off for a stay at a dog-sitter [page 191] (a few days later, when they got back

[7] "This was the first time Stella said a word without requesting an object or an action from one of us. She walked out of the sunroom, down the hall, and into the dining room all simply to tell me what she observed in the world around her." [page 84]

[8] Hunger describes how — after having moved the buttons to a board, so that Stella needed to learn the placement of different words — she said "help" repeatedly [page 161].

[9] In another example of the ocean-water generalization, she said "love you water" — probably pleading to go to the beach, with a solicitous "love you" for emphasis.

to San Diego, Stella saw the sitter packing up her belongings and realized they would be coming soon, saying "Jake Christina" with the buttons). Likewise, a video shows Stella frustrated because she wants to go out, saying "want want love you bye bye Stella" then walking to the door.[10] The pattern underlying *bye* in these cases is going from inside to outside, but the situational details are different — sometimes Stella talks about *her* being inside and then going out (or wanting to), other times about her *staying* inside while someone else goes out. Also, Stella presses "bye" in contexts where she's thinking specifically about going *from* inside *to* outside, as opposed to saying "outside" or (e.g.) "walk" when she is focused instead on what she will do *after* leaving.

Also noteworthy was that Stella seems comfortable with "no," which does not have a concrete correlation to objects or actions but rather plays a more indirect role of altering the rest of the conversation. Hunger describes trying to give her a homemade dinner one night, which evidently she found unappetizing, using the buttons to say "eat no" — next day Hunger restocked on Stella's usual food, and after her meal Stella made a point of saying "happy eat" [page 214]. She also said "eat no" when her sitter did not feed her on time; and also, when Christina did not feed her when expected because of the Daylight Saving time adjustment, said "help eat" and then — Christina was still trying to get her to adjust to the new clock — "love you no" [page 150]. Once "when Jake went out of town for a few days, Stella said, 'Jake no bed', before she hopped up on his side of the bed and slept there for the night" [page 196] — which shows her generalizing the concept of "bed," but also commenting on Jake's absence via "no"; if he's not here, I might as well sleep on his spot. She used "no" to model both logical negation (what has not happened, or — recall her conveying that she had knocked something over accidentally — what was not intentional) and emotional states, alongside words/phrases like "happy", "mad," and "love you." In short, her conceptual repertoire, as manifest in her expressions, covered the gamut from nouns to verbs to more abstract ideas, and was sensitive to concepts' adaptability across distinct situations.

When seen through the lens of our scientific interest in the extent of animals' linguistic capabilities, Stella's communication is noteworthy less for the size of her vocabulary (in contrast to Chaser, say) then for how realistically she fits words into situational contexts. The actual words are clearly just one thread in an acute awareness Stella has of the routines and thoughts of the people around her, so that for example after eating Christina (on a video) can say "all done eat, what now?" and Stella confidently respond "play outside," an exchange that would not be out of place if it occurred between a parent and a (human) child, at least if we morphosyntactically decorate "eat" to "eating." Stella did not just use words statically, like the name of a toy; she packaged words in different combinations given the situation at hand.

Hunger gives many examples that reveal Stella's highly situational use of language. Once she found a "ratty scrap of some other dog's toy" and brought it home [page 212]; Christina was reluctant to actually bring the toy in the house. Stella wasn't happy. She stood by the door and then said "toy inside" (probably a novel combination of words, because all of her toys usually *are* inside).

One evening when friends were visiting, Stella got impatient while they were all talking by the door preparing to leave, finally hit the "bye" button before looking up at the guests [page 109]. Another visitor-anecdote has her playing with guests when Christina came over to pet her, and Stella reacted by saying "Christina later" — again, a combination that would not fit except in specific kinds of circumstances (here she wanted to play with her new friends without being disturbed, presumably). Stella got into the habit of saying "all done bed"[11] in the morning to announce when she was awake (and ready for food and walk) or "help bed" at night when she wanted to go to sleep and wanted someone to open the bedroom door [page 196]. She said "love you" when Jake and Christina were hugging each other, squeezing between them [page 137]. She said "all done" when she wanted Christina to stop vacuuming [page 202] and "all done walk ... want" and then "Stella bye love you," standing by the door, when they were setting up furniture after a move, indicating that her annoyance with all the commotion and that she wanted to go for a walk instead [page 210]. She said "love you" to guests that she especially liked [page 178], and likewise when Christina was sick in bed [page 154], both times getting up from the bed or sofa on her own volition to do so then returning to her prior spot. She used the buttons for "park" and "beach" to indicate on a given day which way she wanted to walk, after the family moved to an apartment a few minutes from both her favorite spots.

All of these situational, conceptual, and interpersonal details suggest that Stella is bringing to language intellectual dispositions that actually mirror those of human speech. The breadth of Stella's understanding, in short, is evidenced most strongly in this cognitive infrastructure, more so than in lexical or syntactic scope. The semantics of Stella's "language" is relatively informal and ad hoc — she developed her own routines for using words in specific ways, not necessarily those Hunger anticipated when recording the words, or their normal English meanings. Thus "bye" for "leave"; "no" for "not"; "help" or "love you" for "please" [page 168]. Stella's "grammar" could also be haphazard. She would use word-sequences to suggest patterns in time — "bed eat outside," say, to communicate how, in the morning (after she's out of bed) she wants to eat and then go for a walk [page 197] — but she probably was not in these contexts following what she perceived as linguistic rules, but rather pawing-out words in combinations that seemed to make sense in context. The point is not that Stella's use of language lacked syntax or semantics, but that she does not seem to believe that rigid semantic and syntactic rules are prerequisite for successful communication. Instead, she seems prepared to stretch words' meanings and combinatorial possibilities informally, almost experimentally, trying to modulate the language available to her in response to the specifics of each situation in itself.

Stella also clearly has self-awareness. She used the button recorded with her own name in ways that almost prove her being aware that "Stella" named herself in the same way that Jake and Christina named her people. She stood looking at herself in the mirror when she had carried a toy or a tree branch [photo after page 150]. Stella clearly understands herself to be a participant in situations alongside other people, each with their own (perhaps slightly different) beliefs and perspectives, and realizes that she can use language to alter how situations play out. In short, Stella's communication shows that she understands the world in situational terms, and sees situations through an agent/participant lens, cognitively structuring states of affairs in terms of the beliefs and intentions of cognitive agents (including herself, and the people whose lives she shares).

[10] Apparently Stella also started to use "bye" to indirectly designate peanut butter, because her people left her peanut butter as a treat when they went out: "bye eat" became her homespun phrase signifying the treats they left her before going "bye."

[11] Video, https://www.youtube.com/watch?v=g5xtDyOju8E

2.1 Lessons for Natural Language

To what degree can we generalize from Stella's story to broader insights about animal cognition, and even human language itself? At one level Stella's speech-acts are primitive, when compared to human language but perhaps even when compared to animal sign-systems that have strict patterns and, through those patterns, permit complex variations. Animal-communication research has shown how many primates and cetaceans — or even apparently more primitive mammals, like prairie dogs (who are not canines, but rather related to groundhogs and squirrels) — can modulate their vocalizations to express several different levels of detail about, for example, lurking predators. These sorts of communications (likewise for many species' birdsongs as well) reveal a kind of modularity, where parts of coded messages can take on various forms, with the messages in their entirely therefore able to span a variety of uses and circumstances. This would seem to be analogous to phenomena in human language such as verb tenses, noun-declension, and other lexeme-level markings that adjust sentences' sense of time and place.

Because AAC buttons do not allow that kind of modular fine-tuning, we cannot directly compare dog's use of speech-assisted human words to other species' native vocalizations, which could have evolved for subtle modulations alongside the evolution of the vocal apparatus itself. Still, it is entirely possible that some species' communications reveal a syntactic and/or morphological complexity that outstrips Stella and Bunny on AAC boards. And yet, it certainly feels as if "talking dogs" are *communicating* with *us* on a level that would be hard to conceive with almost all other animals.[12] We would suggest that this reinforces one's impressions wherein lexical and syntactic norms are not the predominant criteria for (human) language's sophistication.[13]

From the perspective of Cognitive Linguistics, the structural rigor of human language derives less from semantic and syntactic formality and more from structural correlations between conversants' situational understanding. There is a prelinguistic co-awareness which lies behind our intersubjective interactions, and we are disposed to treat units of language — both words and syntactic paradigms — as tools that can and should be adapted for different scenarios. It is easy to imagine or recall contexts where people stretch word-meanings in novel ways; sometimes clever turns of phrase become popular and end up being just another word-meaning (considered "primaried" as a verb, or "Watergate" as an adjective: Donald Trump's "Watergate moment").

In essence, we cross the threshold of language not by acquiring sufficient competence in static lexical-grammatic systems but rather in engaging with other people with sufficient prelinguistic understanding that we are able to extend our interactions via linguistic constructions, with some degree of legibility. On this theory, the building blocks of language are those which undergird collaborative situational awareness, more so than those which are structural units of morphosyntax, dictionaries, or syntactic templates. Animal-cognition observations such as Stella's speech-acts can help us understand the cognitive and experiential foundations of *these* pre-linguistic faculties, which appear to bring us to the core of language itself.

As implied above, there are three dimensions to Stella's discourse which — relative to what we might expect from nonhuman animals — seem surprisingly advanced. Specifically, she has a highly developed situational awareness, comfortable in the midst of people and participating in human activities; she has a detailed and logically coherent "theory of other minds"; and she understands concepts in flexible ways, extending and reusing concepts (like "water") in variegated forms across situations. A linguist or philosopher grounded in Cognitive-Grammatic paradigms might be inclined to focus on these specific strata — conceptual plasticity, situational awareness, and "theory of mind" — as language's inner nexus anyhow, but it is intriguing to witness this paradigm be embodied in a one-year-old puppy.

Experimental dog-cognition research certainly confirms (or at least strongly intimates) that dogs do have an acute understanding of "human" thoughts and situations. Talk buttons can add a further dimension to this line of investigation, not only because there is a new kind of empirical resource (videos or accounts of dogs' speech-acts via the buttons) but also because they add an extra cognitive layer which we need to understand in the context of their thought processes. It is one thing to innately or implicitly appraise a situation, in the sense of overlaying structures of categorization and action-planning over raw experience (which we can assume is a natural instinct: the world can be classified into things which move, things which provide sustenance, and so forth, with their own action-possibilities(things that move can be chased, food and water can be consumed). It is another to deliberately destructure this awareness and intentionality and present it to someone else in the form of (button-assisted) spoken words.

Incorporating speech-acts into her pragmatic repertoire requires, on Stella's part, something akin to (what is sometimes called) metacognition. Alot of our situational awareness is subconscious — we plan and react instinctively, playing out innate (or entrenched) enactive scripts, calibrating our actions to our (not-entirely-predictable) surroundings but without sustained deliberation. Presumably it takes a level of cognitive distance from such fully "immersive" functioning to communicate *about* our surroundings, especially when our communicative mechanism is a device that takes time and planning to use.

Situations, conceptualizations, and construals about other people's "epistemic attitudes" are constituent strata of prelinguistic understanding. How do these layers coalesce into language proper? Certainly, the strata overlap, and they are threaded together: concepts are adaptable, for example, because one concept has multiple variations that fit divergent situations (water in a dish and the ocean, say). We form cognitive schemata for situations by appraising how relevant concepts are narrowed and modulated via their manifestation in *this particular* state of affairs. Other people likewise, we realize, perceive the same situations from their own perspectives, and are engaged in analogous conceptualization; our awareness of that process — as something generic to context-actors, not just in our own mind — and its concordances and deviations from our own conceptualizations gestates our "theory of other minds." So concepts build to situation-schemata, and multi-person situations situate us in a shared epistemic space.

At the same time, intersubjective awareness supplies a structuring principle regulating situations. Stella is, of course, quite self-aware; again, she uses her name to refer to herself when "talking," and studies herself in the mirror.[14] Self-awareness then implicitly extrapolates to situational schema; if she wants to go outside, it is *her* location

[12] Perhaps except higher primates, as evidenced by Koko and other gorillas and bonobos who learned (something like) sign language.

[13] Indeed, spoken language tends to be more ad-hoc than the norms of written dialects dictate — during conversation and in the midst of concrete activity people regularly speak in sentence-fragments, overlapping conversational turns, fast-paced enunciation which elides morphological markings, and in general produce speech-acts that can trip up computational systems engineered to recognize relatively formulaic and well-structured discourse.

[14] In particular, as we cited earlier, Hunger reports that she goes over to the mirror *when carrying* a toy or tree-branch, an occasion-specific and deliberate act which strongly suggests that she identifies herself, rather than merely happening upon the appearance of a dog which she might ponder without self-recognition.

that orients the inside/outside contract. *She* is inside now and will (or would) be outside afterward. We conceptualize inside/outside *qua* schema by projecting ourselves as a "trajector" sited first here then there. Of course, schemas exist where someone or something *else* participates in the inside/outside duality — consider "help outside" on Stella's seeing a dog-stranger — but this very conceptualization depends on consciousness of "what it is like" to be one place or the other. The designation "outside" is meaningful because of prior (retained) and, at some level, anticipated (protained) consciousness of phenomena there.[15]

It is easy to see how drive-based self-awareness propels schemas like inside/outside to become phenomenologically entrenched. A dog wants to go outside to pee, play, and so forth; there is an explicitness to such desires and a vivid contrast between inside- versus and outside-experience that the particular inside/outside schema, we envision, could become cognitively registered merely via subjective intensity.

As a structuring principle, however, schemata take full form as we project outward from *our* intentionality to other people's, drawing in "other minds." We can take schemata nurtured through experiences where *we* entertain actions or observations, and restage their structures with others in our place: another person going outside, "having" left, "eating," and so on (here citing schemas reflected in various Stella speech-occasions). Stella for example said "bye" when a house-guest had departed after a several-days stay — Stella was resting on the spot where the guest had slept (Stella had also seen her leave at the airport); she generalized "bye" from a temporally localized reference to the *act* of leaving to the more generic state of *having* left [page 139]. Stella might say "eat" when seeing Jake and Christina doing so, without intending to ask for food [page 134]. Cueing the others to look outside ("help outside") implicitly translates the inside/outside trajector to something more abstract: instead of *going* outside we just *look* outside.[16] Apparently she generalizes "outside" from the physical dynamics of going/having-gone to the more epistemic concept of "outside" as a surrounding place to be observed/monitored.

Ideas of look/gaze, of who-sees-what, invites other-mind issues because belief-formation is driven primarily by seeing things. As such, intrinsic to many cognitive schemata are notions of how we visually navigate through surroundings; in practice this includes tracking other peoples' gaze, as well as cooperative phenomena such as "joint attention" that Hunger discusses in the context of her preliminary realization about how Stella's actions as a young puppy resembled babies during the early stages of language development [page 41]. Recognizing where other people are looking and what they are seeing is presumably an important component of our emergent understanding of other people's minds, which it turn generalizes to schemata having one structural scaffolding comprising of people's physical orientation within situations and how this permits certain lines-of-sight (or blocks others), part of a more general sense of belief-formation.

Here, then, we can see a kind of schematic expansion outside of somatic/subjective schemas driven by our own experience to multi-person collaboration, which involves both generalizing from *our* positioning vis-à-vis situations (going outside in the sense of *our* movement from here to there) to the schematic form with our own presence elided (something *else* going outside, or, something outside when we see it from inside, or, via counterfactuality, something outside which *could be* inside, like Stella's toy-find) — and then generalizing to schematic configurations centered on someone else; some *other* person going/looking/being outside, say. Schemata may be tuned along these axes, like knobs being dialed, with configurations being more or less grounded on specific people at spatiotemporal schematic positions, and with such agent-positions being understood more subjectively (one's own experience) or more via extrapolation (either imagining other minds immersed in situations or inferring the epistemic invariants investing situations with coherent belief-forming potentialities, that can be abstracted from any one subject's perceptions).

Awareness of other minds, on this account, is a central element in how we generalize subject-relative schemata to an understanding of more neutral/impersonal belief-formation; this is what a *typical* epistemic agent would believe, or what we should *expect* someone to believe, experiencing such-and-such a situation from their specific perspective. Such argumentation alludes to a phenomenological tradition where metaphysical notions of the world's intrinsic facticity are grounding in collective action and intersubjective consciousness. Traditionally, of course, phenomenologists have understood the truth-disclosing quintessence of the world's givenness, its ability to be known and availability for knowledge, as a cooperative resource of the collective *human* community; we, speaking globally, through communication and collaboration, invest reality with epistemic potential. In light of animal-cognition research, perhaps we now need to expand this intersubjective vision to encompass animals as well.

Understanding "other minds" has two overall dimensions — we have awareness of *particular* individuals' beliefs and also the *general* beliefs that would be warranted circumstantially. In the context of experiments where, for example, animals or children watch scenes playing out some form of hidden-in-box trick, the experiment's subjects often take the place of a "neutral observer" who knows a treat has been, let's say, surreptitiously moved from one box to another, whereas someone who wants to find the treat is misled. At a sufficiently advanced stage, children will anticipate *false* beliefs, and expect someone to look in the box where they *think* the treat is to be found, whereas the experiment-subjects know the treat is elsewhere. As such they distinguish between beliefs that are *warranted* by all the available facts, from beliefs that are coherent for a party with limited facts, or an occluded perspective, but are actually erroneous. To conceive of a "neutral" perspective, one with maximal access to relevant information, however, is essentially to imagine an epistemic collective, the sum total of everyone's perspectives to the degree that we can aggregate all facts available all people (at least all people witnessing a given scene). The fact that the treat is in its actual box, for instance, is witnessed by how someone watching the scene neutrally can *see* the treat being placed there.

In the context of Stella's communication, it seems clear that she is implicitly able to reason about other minds both from general and from particular perspectives. Her communiqués sometimes reflect assessments of one specific person's thoughts (like telling Jake that she and Christina had been to the park), and sometimes comment on, or perhaps seek confirmation about, general facts (like her saying that their weekend guest had gone "bye").

Considering these details about Stella's "epistemic" awareness, alongside her situational understanding and agility in extending and modulating concepts, there should be little doubt that Stella's communication reveals much of the cognitive architecture underlying human

[15] Phenomenologically, we cannot think of an "inside" without conceiving that there is around there some "outside."

[16] That kind of generalization applies to the unfamiliar dog outside, but also one case Hunger mentions, early on, where Stella typically used her "outside" button to prompt going out to their back yard — except on one occasion, hearing Jake using a lawn mower at the *front*, asked for "outside" and ran that direction instead, apparently both seeking to investigate the unfamiliar noise and alerting her people about the (for her) confounding sound and appearance of a lawn mower [page 83].

language. Her level of "prelinguistic" competence, in short, is more apparent if we look at the circumstances surrounding particular speech-acts than if we consider what she says in isolation, just as strings of words. Insofar as Stella observations are so far mostly anecdotal, drawing comparisons between this research and prior analyses conducted in a more rigorous, laboratory setting cannot be more than provisional; but, with that said, we do think there are subtle clues that Stella's thought processes deviate from prior models of canine intelligence, even those carried out with a strong belief in dogs' innate intelligence.

3 Joint Attention and the Foundations of Language

Videos of Stella and Bunny show their dogs in familiar, day-to-day environments. In that milieu dogs appear to have a cognitive repertoire more expansive than previously documented, even by researchers largely sympathetic to claims of canine intelligence. One theory is that within more conventional scientific experiments there is a higher threshold for empirical rigor, so Bunny and Stella observations remain tentative at best. Alternatively, perhaps cognitive studies are *more* accurate when sited in normal surroundings, rather than experimental mockups.

For example, backed by neurophysiological research — including fMRI brain scans while dogs played simple games with their owners — Gregory Berns and his colleagues have suggested that dogs' reasoning is oriented (at least, more than people) toward holistic activities rather than abstract/generic concepts. He suspects, say, that his dog Callie perceives the word "hedgehog" as a phrase — essentially meaning *get hedgehog* — rather than an isolated noun: her concepts are episodically pragmatic, more than invested in specific objects or people [4, page 168]. In terms of language, limited grasp of words as individual signifying units (like verbs or nouns) implies limited ability to join words into variegated phrases.

This model would also have to question dogs' capacity for conceptual generalization. Logically, the more that concepts are grounded in *objects*, the more that we can perceive a conceptual continuity when we experience that object in different contexts. Arguing for an activity-centered conceptual predilection, conversely, implies that dogs do not (at least as readily) adapt concepts to multiple different activities.

The same would go for types and kinds, such as "water": this concept re-appears in settings that we, from an activity-based standpoint, will experience in quite different ways — drinking water; watering a plant; playing in the ocean. Berns's models imply that dogs experience concepts with less acuity and granularity in their cross-contextual guise, being more attuned to specific, familiar situations, experienced holistically, with less attention to their conceptual building-blocks.

By extension, Berns questions to what degree dogs recognize their name as a signifier for themselves, in the sense that (while certainly knowing to pay attention when they hear their name called) dogs may equally well interpret that sound as meaning something like "come here" or "look at me." If dogs experience the world activity-wise, their conceptual focus on themselves as a participant in activities would be less intense than thoughts about the activity as a whole, and so there would be less conceptual specificity required for attaching their name to themselves in particular, as opposed to a more diffuse acknowledgement that the sound of their name tends to presage activities of which they are a part.

Here we are emphasizing only one facet of Berns's analyses, but these are the issues which seem most relevant to assessments of dog's "language." If dogs understand linguistic expressions bound up in specific activities, they are less aware of individual concepts in a more abstract vein — perhaps Callie fails to distinguish "hedgehog" (referring to a toy) qua concept from a command or suggestion ("get/bring [me] hedgehog"). Again, similarly, he expresses skepticism about dogs' grasping their names as "direct" symbols for themselves, rather than solicitations for attention (a caregiver's request for the dog to come to them or look at them).

The implication of these positions is that the "semantics" of dogs' innate language would mostly quantify over holisitic activities, like *fetch a toy* and *come to me*, rather than singling out objects in the guise of discrete concepts. Analogously, he questions whether dogs cognitively distinguish nouns from verbs, claiming that only Chaser (the Border Collie who knew over a thousand toy-names) has been documented as clearly making such a distinction, and voices doubts that dogs (including Chaser) could understand significatory aggregates of more than one or two words.

It is these sorts of analyses that seem counter-indicated by Stella and Bunny observations. There is little reason to question that they refers to themselves by name, and because this is self-referential cannot be understood responses to their own names mostly in reaction to people asking to do something, like "come here." Instead, they use their names to describe feelings to other people, via phrases such as "Stella mad" and "bye bye Stella." Stella also uses her name to describe what has already happened, as in "Stella Christina park". Hunger's accounts also strongly suggest that Stella understands concepts in generic/counterfactual contexts, not just bound up operationally à la "fetch hedgehog." Her entreaties like "toy inside" are proposing a state that the toy should be in, not describing an activity such as "play with the toy."

And, of course, Stella and Bunny routinely create multi-word expressions, perhaps five or six words long (apart from repetitions for emphasis), like "love you come outside bye Stella."[17] Looking only at the surface form of their language — the actual words they create via buttons — misses the larger complexity of the ideas they clearly have in mind. This is because their communications are highly context-sensitive. When Stella wants to "eat" and gets impatient because of the clock-change, her subsequent "love you no" is a two-part phrase in isolation, but it actually continues the prior exchange and refers to the current situation, where she is exasperated that her people seemingly have forgotten to give her supper. Moreover, she presumably believes that saying "love you no" will *cause* Jake and Christina to realize that she is unhappy (she did not just keep repeating "eat" the way a dog might scratch at a closed door, hoping someone would eventually realize they want to come inside). In other words, she was not acting out of instinct but commenting on the situation, for the benefit of people around her. The larger meaning of her statement is that she is upset *because* Jake and Christina have not yet fed her. Similarly, "eat no" after returning from the park when she did not eat earlier is just a two-word phrase, but its overall content is a broader idea, along the lines of "I haven't eaten yet (this evening)."

Once we factor in context, we realize that Stella's language can encompass many distinct components in a single phrase, referring back-

[17] Compared to actual human speech, of course, Stella's discourse is fragmentary, but that must be at least in part a product of the relatively primitive communication tools at her disposal (human's own conversations on, e.g., social media, where are more logistically cumbersome than talking in person, are similarly typified by incomplete sentences and abbreviations, or emojis).

wards and forwards in time, spanning multiple people and perspectives, multiple facets to one activity (park play outside), and so on; we cannot measure the complexity of her thoughts just by counting actual words. Simple phrases are no less vehicles of language than elaborate ones. Or, to put it differently, ideas signified linguistically may span multiple time-frames and situational perspectives, not all of which are marked by their own linguistic units; a simpler surface-expression has to refer to such complexities obliquely. But there is still sophisticated *communicative* intentionality involved because the enunciator needs to anticipate *how* addresses will absorb such expressions (even simple ones), filling in the gaps.

Given how her talking relates to situations, we can infer the ideas Stella intends to communicate — and, indeed, perceive that she anticipates how her people will understand her communication on the basis of her words *in context*. She probably would not say "love you no" unless she guessed that Jake and Christina would recognize this as describing her impatience and, in the context of that moment, understand *why* she was angry.

It is true that Stella's and Bunny's language does not have particularly complex syntactic structure, and one might reasonably doubt whether dogs could learn a sort of language which rivals humans' in the sense of using grammatic rules and morphological markings to form complex linguistic constructions. Another way to say this is that dogs might not be able to *encode* complex ideas into equally complex language. However, this limitation is a different issue than dogs' possessing complex thoughts to begin with. A lot of cognitive detail may get filtered out by the primitive nature of AAC buttons; so "I have not eaten (tonight)" becomes just "eat no." But that does not really affect the important cognitive point, which is the complexity of thoughts held in the mind. Even Stella's simple language expresses her thoughts, in context: the main point of language is communication. She uses simple phrases to convey complex ideas, and we can assume much of that dialog is deliberate and self-conscious given her assessment of how people hearing what she "says" with the buttons will interpret that — again, *in context*.

Moreover, almost surly Stella's self-awareness is more individuated than Berns's model implies. Consider how she coherently and pointedly uses her name when talking, often for emphasis, or to solicit her people's attention. That is, she might say "come outside" when she has a rather neutral opinion about going out [page 143, 147, 174, 181, 197] but "bye bye Stella" when she was especially frustrated [video cited earlier]. She obviously understands that the people around her use this name to designate her specifically, and would pay attention to her through the name the way they attend to other objects referenced by name, and to one another. Her self-awareness, in short, is individuated and singular in the sense that she knows how people have a concept for her in particular, a sense probably reinforced by mirror-recognition. She is Stella in the same way that Jake is Jake and Christina is Christina. By extension, Stella uses her people's names to refer to them as she would use her own name to refer to herself. Such self- and other-awareness is surely a factor in how Stella employs simple expressions to communicate complex thoughts. Stella has the patience to produce compound speech-acts because she believes they cause her feelings and opinions to be known to Jake and Christina (and sometimes others).

To clarify, Berns's neuroscientific research in general yielded strong evidence of dogs' intelligence, and he personally has forcefully advocated that dogs get proper respect and ethical credit, proposing for example "personhood" legislation that would prohibit unpleasant experimentation, dog racing, and other potentially inhumane treatment. We raise no larger-scale dispute with any of this work, which would be out of context here anyhow; we merely want to consider specifically the ideas Berns puts forth about dogs' intelligence in the context of cognitive schemata. In that vein, Stella and Bunny appear to refute almost every claim Berns makes about dogs' cognitive limitations. More subtly, perhaps, she appears to counter-indicate generalizations made by other prominent dog-cognition researchers, such as Brian Hare. In one revealing passage, Hare (a few years before Stella was born) was discussing Alexandre Rossi, a Brazilian researcher who programmed speech buttons somewhat similar to Hunger's; Hare then wondered whether Rossi's dogs could form simple phrases like two-word combinations [19, page 138], apparently not even imagining the loquaciousness of later "talking" dogs. Like Berns, Hare also voices skepticism about the extent of dogs' self-awareness and theory of (other) minds.

In this context, it is interesting to note that — although outside an "academic" or scientific context proper — Hare was interviewed about Stella on slate.com and raised questions that deserve response from anyone taking "talking dog" accounts mostly at face value, as we admit to doing here.[18] The tenor of Hare's comments implies that he accepts the premise wherein dogs may indeed learn to associate individual words with certain actions or outcomes, and perhaps short phrases, but he apparently believes more work is needed to demonstrate that dogs can formulate compound phrases characteristic of language proper. Granted, in isolation (or even, say, paired with one other word) a single word is not really a linguistic artifact, but rather a sound correlated with some idea at the same level as other gestures might be, such as touching a paw to a bowl to connote "water"; spoken words without linguistic structuration are in effect just vocal gestures. Hare also appears to base his assessments on published videos of Stella and does not refer to Hunger's book-length treatment.[19]

However, multiple published videos reveal Stella communicating via multi-part phrases, such as "want, love you, Stella bye bye" (mentioned earlier) or "help Christina inside blanket" when Stella was looking for her blanket. These videos are consistent with Hunger's descriptions of similar episodes, so it is reasonable to consider the existing videos to be relatively strong indicators that Hunger's textual descriptions are accurate enough to serve as (at least preliminary) data points. Hare also implies that Hunger is projecting interpretations *onto* Stella's words. A cautious reading of Stella data might suggest that her communication has some legitimate features of language — e.g., she specifically uses words to convey ideas or desires, with some understanding of what the words mean (or at least a correspondence between the word-sound and the correlated concept), and that the people she is addressing understand her communicative intent. Nonetheless — or this is an explanation we can consider — her word-combinations might be rather haphazard: she could guess that since "beach" has something to do with water that is outside, sounding out these two words will get people's attention focused in this direction; her strategy of stringing words together may not have sufficient structure in her own mind to qualify as properly linguistic phrase-formation. Language proper has an intentionality that cannot be directly equated with experimentally producing words for several related concepts in the hopes that, on aggregate, the totality of the concepts expressed will communicate

[18] https://slate.com/technology/2019/11/stella-christina-hunger-instagram-dog-speech.html

[19] It is true that the book's descriptions of Stella's communication sometimes cite incidents that have not been recorded, or at least the book does not cross-reference text to video. But even if we take these accounts as preliminary work that would need to be generalized to reach optimal scientific status, perhaps statistical comparing videos from multiple dogs, Hunger's and Devine's pioneering work with Stella and Bunny are a valuable starting point.

some underlying idea.

While it is true that "experimental" attempts to approximate ideas by sounding out multiple related concepts should be distinguished from using words in linguistic ways, it is not unreasonable to speculate that such experimentation is a *stage* on the way to acquiring language proper. In that case we can consider whether Stella has *only* reached that stage or whether she has gone on to mix words with *deliberate* and *premeditated* intent and structure. In the latter case we should argue that Stella has progressed to cognizing and using words in a properly linguistic vein. Even when dogs' language-use modulates or cycles between properly linguistic episodes and something more hesitant, like exploring buttons and word-combinations to assess humans' responses, would not this actually suggest that dogs are *learning* some language?

In the interview mentioned above, Hare cites Occam's razor to look for the "simplest" explanation of Stella's behavior — maybe she associates the buttons with specific concepts and specific positive outcomes, and so she uses them *intelligently* but not necessarily *linguistically*? Given the totality of evidence, however (combining video and descriptive observations) we think the simplest explanation is actually that Stella (and also Bunny, often) forms multi-word phrases deliberately and with attention to aggregate conceptual structures. On video, for example, their sequence of button-presses appears to be premeditated and to construe a group of produces words as a unit: notice how Stella looks down at the button-set while she is walking through a sequence, and only after the last word looks up to see Christina's response. This implies that Stella knows in advance what multi-step word group she wanted to produce, and was not only adding on new words by "trial and error." The fact that Stella often "talked" of her own initiative, including when people around her had their attention directed elsewhere, implies that Stella was not just getting cues from humans on which button to press (contra suggestions that her apparent language-understanding was mostly mimetic, analogous to Clever Hans's arithmetic), again pointing toward the *simpler* theory being how Stella *does* use words linguistically (albeit at a relatively primitive, child-like level) rather than that she *doesn't*.

Likewise, implications that Hunger misreads or even deliberately misrepresents Stella's actions are plausible but *more* far-fetched than reading the contents of *How Stella Learned to Talk* as largely reliable. Finally, Stella's use of words in context-specific ways — commenting on people arriving or departing, sounding out "friend" to express affection for her little brother (that is, her caregivers' human child), and so forth — invite us to consider Stella's grasp of conceptual aggregates not only in terms of actual word-combinations (which might be subject to interpretation vis-à-vis how deliberately they are intended), because even a one or two-word phrase reveals multi-faceted underlying conceptualizations when it only makes sense in a detailed and situation-specific context.[20]

If we consider also Stella's apparent conceptual extrapolations, with "water" for instance recurring in many contexts, we should be inclined to conclude that Stella experiences situations as aggregates of conceptual building-blocks, rather than concepts as localized to situations — arguing against suggestions that dogs think almost entirely through gestalts such as "hedgehog" meaning "get hedgehog" rather than through concepts referring to individual objects or object-kinds. Stella's deployment of concepts in situation-schemas, in short, would tend to be "analytic" in human-like ways, where concepts (modulated by context) chain up to form situational representations [39, page 150], as opposed to "holistic," where we experience situations as gestalts and have a vaguer sense of concepts extending across situations.

Berns's research suggesting otherwise is perhaps an artifact of his experimental methodology: he did not scan dogs in their normal lives living with people (which would be infeasible if special tools are needed for brain scans); instead, he could only scan subjects doing a narrow range of activities which are possible when laying still for an protracted time, for the scan to work (e.g., 30 seconds). Or, in the case of fetch-toy style games, these are supposed to be fun activities for dogs who might get bored before long, so their attention wanders elsewhere. If the kinds of activities Berns's team set up for intelligence tests or fMRI scans are different from the norms of their day-to-day lives, it is not surprising that they would register different cognitive patterns, being more conceptually isolated and self-contained as compared to situations that are more familiar — the very divergence of such situations from dog's habits would incline concepts to be more narrowly rendered as parts of the situation than would be the case for experiences that are less atypical.

Similar comments could be made about Hare's experiments, even if they are carried out in a more natural setting than the limited tasks dogs can perform in an MRI scanner. Strange scenarios fabricated to quantify animals' reasoning — such as knowing where to look for a treat hidden beneath one of two cups — are an imperfect stand-in for the routines of a dog's life shared with humans. Dogs reason intelligently about the totality of their life-world in conjunction with their care-givers, where they can make inferences informed by habits and routines, observing humans' actions and emotions, even by the current place and time of day (e.g., dogs usually get food in the kitchen or treats when they are walking or playing outside).

Most of these internalized contexts and cues are absent from the settings where cognition tests would typically be performed. Of course, problem-solving in unfamiliar contexts is one dimension of intelligence, but measuring *only* this aspect of cognition does not properly observe thought-processes in the plurality of subjects' lives (humans, too, are less intelligent when navigating unfamiliar territory — consider trying to find an address in a foreign city, or a book in a new library).

We think a hypothesis worth pursuing is that recent dog-cognition research has accepted an overly simplistic *emotional* portrait of our canine companions, which end up distorting their *cognitive* theories. At one point in *The Genius of Dogs*, for example, Hare cites experiments about dogs "disobeying" people, which would run sort of as follows: owners place food on the floor but also instruct dogs to "lie down," implying that the dogs may not go to take the food [19, page 245]. The owners then engage in various activities differentiated by how clearly they appear to be distracted, and/or are positioned so that they can or cannot observe the dog's behavior. Experimenters then test when and whether the subjects break from the "laying down" position to get the food. Hare discusses these experiments in terms of the dogs being tempted to counter owners' instructions, but hoping they don't notice.

Issues of obedience are also endemic to "trainability," which is often treated as a central factor (perhaps the most quantifiable metric) for dogs' intelligence. It is hard to measure whether a dog who fails to perform a certain trick or action does not understand what a person is requesting or simply isn't motivated to play along. However, it is generally assumed that dogs want to please their humans, and if that is not sufficient incentive their interest can be sparked by treats. The

[20] Stella's relationship with the Hunger's baby boy (born after *How Stella Learned to Talk* was written) is not profiled in published writing, but she discusses Stella's affection for the child on social media.

overall picture is that dogs have motivation for praise and treats and — when behaving intelligently — should regard humans' requests as means to obtain one or both; which may include solving some sort of puzzle or reasoning task. At the same time, dogs' motivation for rewards like treats may override their interest in human praise.

This account may be too superficial because it breaks down dogs' motivations into simple units — treats, praise — and expects those to act as motivating factors in their using intelligence to think through hindrances. Such paradigms simplify the role of intersubjectivty, treating dogs either as pliantly calculating how to get rewards or as obstinate rebels willing to counter owners' wishes. A more nuanced picture is that dogs perceive their relationship with caregivers as cooperative: after all, humans feed dogs multiple times every day, and in other ways care for them, so (at least properly loved) dogs implicitly understand that humans care about their well-being. Dog-lovers are happy when their dogs are happy, an emotion which the latter surely perceive, and reciprocate; dogs are protective of people in part because of a certain sympathetic mirroring — dogs are contented when their people are secure and protected. Dogs and caregivers share bonds of mutual empathy, where positive and negative emotions for one party become instinctively shared by the other.

In this context, dogs presumably follow along with human requests because they perceive that doing so will make us happy. Probably this often takes the form of dogs experiencing activities as games: they may bring a ball or toy to humans to initiate play, and they probably believe we are doing the same with tasks and routines such as "sit", "lie down," or the (sometimes rather convoluted) actions or puzzles formulates by cognitive scientists. While researchers may be interested problem-solving or fMRI scans, the subjects probably think that these requests are a kind of game, and that we want to play because doing so makes us happy. So dogs play along, and expect the activity to progress the way playtime usually does. Putting ourselves in their shoes: if we then follow up with gestures that seem out of place in a game scenario — like putting down food and saying "lie down" but then turning away to read a book, or engaging with the dog by pointing in different directions but then turning our back (supposedly to test for "directional preference") — we can easily see dogs struggling to understand what we are actually trying to accomplish.

By analogy, imagine if your best (human) friend suddenly starting carrying out unusual and disjointed behaviors, like putting food underneath a cup (instead of a normal plate, for people, or bowl, for dogs), or randomly stretching their arms in strange directions. You would probably find their behavior weird, and be unsure how to react. If dogs perceive many of their interactions with us as akin to games, then they may perceive our specific requests and instructions as attempts to follow a certain "play" script — in the same way that humans playing games together accept certain rules (without which games would not be much fun). That would explain why we care about whether a dog is sitting or lying down, for example, or whether she moves when we make one sort of hand gesture but not another. But game-playing involves expected behaviors and comportments; we anticipate participants to show signs of enjoying themselves (smiling, laughing, and so forth) and to act physically as if they are having fun. When we fail to act as if the interactions we are having with dogs is play-like for us, then dogs plausibly get confused, and start trying to figure out what we actually want them to do. Probably most dogs would never imagine that activities we rig up to test their intelligence are some sort of scientific experiment rather than a form of play-time (after all, you probably would not guess that your bizarrely-acting friend was actually carrying out cognitive research on you).

In short, dogs' cognition naturally takes place in a co-operative mode with humans where both sides mirror each other's fun/happiness, a resonance which inspires cognitive intersubjectivity. Humans acting in ways that seem nonsensical relative to this normal relationship can understandably leave dogs confused and uncertain about what their humans want, a lack of clarity that potentially manifests itself as difficulty reasoning through situations intelligently. After all, it is not as though dogs realize they are being tested. For example, if a person places food on the floor — especially a person who has always fed them — why would they not allow dogs to go get the food?

To put it formulaically, experiments may be poorly designed if their implementation can easily yield "emotional" anomalies that distort dogs' normal thought patterns. Reading emotional cues (for both dogs and people) is an essential aspect of situational understanding. Experiments that force people into unusual behaviors also prevent us from engaging with dogs through our instinctive emotional patterns, which in turn makes it harder for them to adapt to the situation at hand — but humans also can get befuddled if other peoples' emotional reactions do not seem to match current situations in an expected or rational manner.

The point here is not that artificial experiment-situations never yield worthwhile data, but that we should be skeptical about making generalizations about canine intelligence (especially negative ones) on such a basis. The optimal milieu to assess canine cognition is through the lens of normal daily lives amongst people; in particular, here emotional cues evolve alongside situations organically, insofar as we instinctively project emotions in familiar ways, so that dogs can recognize these emotional patterns alongside observing our behaviors. Emotion and reason go hand-in-hand in multiple ways, and one manifestation of this synergy in particular is that observing other's apparent emotional state helps us reason through intersubjective situations.

While not equating dog and human intelligence (any more than we would find it meaningful to compare adult reasoning to toddlers'), in their familiar contexts we should, we contend, be inclined to postulate that dogs experience situations much like ourselves, in the fundamental patterns of cognitive structures and attentional dispositions. In particular, we should hypothesize that they experience discrete objects (and persons/animals) as self-contained particulars that over time will reappear in different kinds of situations, each one structurally different. Such recurrence of specific objects grounds significatory potential, because it endows things with a continuity and individuation that make it sensible for them to the "named." Of course people have names like objects do — and so do dogs, who in turn have a selfhood, a capacity to be part of situations (with some autonomy) alongside humans. Stella is clearly aware that "Stella" is *her* name.

It is also reasonable to speculate that patterns of conceptualization — with objects' perdurance and individuation foregrounded — are an important part of Stella's self-awareness. Insofar as situations are logically formed from conceptual building-blocks, Stella can reason and even communicate about her surroundings, acquiring greater agency by, at least in part, influencing them. When saying "toy inside," for example, she is not signaling desire for an *activity*, or something relatively non-individuated, like "play outside." Rather, she mentally and linguistically singles out one object in particular (the toy she found) and envisions a specific state of affairs structured around the toy (now it is in the yard; she wants it in the house). Intellectually, these communications involve frames of reference and counterfactuality that

are built up atomistically; they have structural networks that gestate compositionally, constructions that may be embodied in linguistic form (in the sense of, say, Construction Grammar).

Situations are also sometimes represented temporally with analogous structural assemblage, such as sounding "bed eat outside" to assert that, having gotten out of bed, Stella intends to have breakfast then go for a walk [page 197]. It is reasonable to guess that Stella's self-awareness includes a notion of *agency*, and that this is bound up with a certain "analytic" tendency to understand situations as concept-aggregates, insofar as concepts serve as the points of contact between multiple parties' perspectives on (their shared) situations. Analytic schemas allow co-operating agents to share ideas, plans, and opinions.

We think one should therefore question Brian Hare's own skepticism about whether dogs entertain to any substantial degree plans or anticipations about the future, or Berns's skepticism about dogs recognizing their own name or image. Hare *has* emphasized that dogs' intelligence draws heavily on "social" communion and inter-subjectivity, and he has documented pro-social, cooperative behavior among other animals (notably bonobos).[21] Hare and Vanessa Woods have even generalized ideas about pro-sociality and the cognitive benefits of intersubjective awareness to a kind of ethicopolitical thesis whereby humans have "self-domesticated," relying on a baseline instinct for collaboration and empathy to survive. This "Survival of the Friendliest" philosophy is explicitly inspired at least in part by the evolutionary success of dogs — who gained protection and care from humans precisely by *being* friendly to us. So dogs' behavior is thematically linked to pro-sociality in bonobos and people, even though Hare hesitates to endorse their exceptionalism in some facets of cognition and intelligence. Even if we accept that dogs do not have neurological resources akin to people and higher primates, however, it is possible that they have a more human-like sense of agency and selfhood than Hare's arguments imply.

Along these lines, it is worth noting that Stella was possessive of her buttons and acted protectively toward the part of the house where her buttons were set up. She would often nap on the floor next to the buttons; when Hunger first moved the buttons to a larger board, Stella asked for the old board back (gesturally) but, it turns out, wanted to use it as a mat (she lay down on it) [page 195]. This behavior implies that she had positive connotations with the buttons in general and with their overall setup. When they took the button-board on vacation and placed it, for instance, in motel rooms, she employed the buttons as usual, so that her experience of talking was not specifically connected to the location of buttons in her own house. It does not seem as if Stella experienced the buttons as toys, per se, but she did clearly consider them part of her territory and her personality. Perhaps she feels empowered because the buttons allow her to express herself and solicit attention from her people. Her behavior, at least, certainly points to her using the buttons on her own volition, not to impress or appease her humans, as if they were some kind of trick. She talks not only to get what *she* wants, but also to send encouragement and positive emotions toward people (rather than the other way around), like saying "I love you" on a day Christina felt sick. In short, Stella appears to deem the buttons an extension or magnification of her personal agency.

Perhaps, in short, one reason that Stella and Bunny were motivated to pay attention toward AAC-like buttons — and to experiment with different phrases, observing humans' responses — is that the dogs wanted to be part of the human world. Talking to each other is one of our most essential human traits, and dogs joining in this activity is a way for them to experience people including them as "peers" in our collective behavior.

3.1 Learning from Humans

Perhaps Stella enjoys the buttons because she perceives them as tools people use, and they allow her to participate in people's activities. Certainly, there are many examples of dogs mimicking humans so as to be more fully included — one can find online videos of a dog who climbs up and sits down on a chair by the dinner table (in the partly-upright "sit" position so her head can be above the table-top); Porter, a dog who rides a bicycle and a scooter; several dogs trained by a group in New Zealand to drive a car — that is, literally start a car and use the gas pedal and steering wheel to maneuver around a circular track (there are no people in the cars with them); Eclipse, the black-lab/bullmastif who became emblematic in Seattle for habitually riding the bus (alone) back and forth to his favorite dog park; and of course Stella and Bunny are joined by other dogs who have learned to talk with speech-assist buttons (videos show a yellow lab named Copper, for instance, communicating in context-specific ways such as sounding "outside mad pool" after a wading pool that Copper loved was disassembled, or "mad Copper no" after not being allowed to have Holloween candy as treats).[22]

In mimicking human beings, we should actually *expect* dogs to process cognitively in human-like ways, even if only because that is what the activities they are trying to master call for. Dogs "in the wild" may deploy, in most situations, cognitive schemata that are less structurally resonant with human thought (at least modern house/apartment-living, urban-dwelling humans). Dogs who have since the start of their lives however spent almost all their time in the same rooms and sharing activities with people, however, would naturally adapt neurologically to the patterns of human life. In particular, schemata that foreground conceptual aggregative architectures and synergy between multiple persons' epistemic attitudes predominate in human experience. It is nonetheless fascinating that dogs have enough neuroplasticity for their cognitive systems to adapt to environments where such schemata present themselves.

In fact, many "human traits" — e.g., language, self-recognition, altruism, advanced planning (cf. Stella's saying before leaving the house whether, that day, she wants to visit the beach or the dog park [page 211]) — are, we have increasingly realized, shared at least on some level by many animals. That may be hard to reconcile with people's supposed skepticism, not too long ago, that animals were even conscious, or at least whether they possessed conscious experiences defined by intelligent thinking rather than rote instinctive drives.[23]

[21] See for instance *Bonobo Handshake* [50] (a clever title because it refers to a gesture where what is being shaked is, um, not the ape's *hand*), written by Hare's sometimes co-author, Vanessa Woods (they're also married) but describing research they conducted in consort (for this context particularly Chapter 5).

[22] See https://www.facebook.com/VTRND/videos/copper-the-talking-dog/1663327744059171/

[23] Simplistically mechanistic or behaviorist models of animal minds are long out of favor, and moreover it is not clear whether anyone literally believed that dogs, say, were actually unfeeling machines. Philosophers will sometimes put down in writing arguments that are stronger than they believe in practice, probably with the goal of advancing a certain skepticism toward commonsensical platitudes that are hard to prove logically — by analogy, a modern scholar who defends claims wherein it is "possible" we are "brains in a vat" (like in the Matrix movies) probably does not believe such claims are actually "possible" in the normal sense of the word, but rather pointing out that they cannot be facilely disproved the way that we can reject a mathematical theorem (e.g., by finding a counter-example). Since (as evidenced by portraiture, say) many people in (e.g.) Descartes' time loved dogs, and the practice of keeping dogs as pets was a feature of that society, we should not naively credit Descartes himself as actually believing the contrarian views that dogs are mere machines, whatever he may have written technically. Still, while extreme behaviorism (completely rejecting any notion of understanding animals, or other people for that matter, from their own perspective as opposed to simply noting their overt behaviors) may be discredited, it is possible that older paradigms still influence our concepts of animal intelligence and may still compel us to exaggerate the degree to which humans are intellectually and morally superior.

While "behaviorism" has been largely abandoned, many scientists seem to be cautious about anthropomorphising animals — arguably behaviorism's opposite extreme — as if we should not attempt, from our own human perspective, to understand animals' experiences. To which perhaps we should respond, why not? Granted anthropomorphising taken to an extreme could hold the risk that we become insensitive to animals' differences from us, potentially yielding a *lack* of empathy and compassion. Obviously it is unfortunate when people punish dogs for doing things that are natural for dogs but not for people, due to our failure to see the difference. But it is not clear that the anthropomorphising is what causes such reactions; after all, people can be similarly prejudiced against other people who are different — in terms of race, religion, culture, and so forth.

Rather, we'd be inclined to argue that concerns about anthropomorphising actually evince a kind of species-essentialism that is itself unscientific. No-one should claim that talking, sitting on a chair at dinner, riding a bus, or driving a car or bicycle are "natural" canine behaviors; doubtless, these are idiosyncratic habits that individual dogs acquired in a world where (among humans) they are commonplace. But by the same argument they are not "natural" for humans either. There is no reason to posit that eating at a table or getting around via motor vehicles are "innate" human behaviors. People adapt to the reality around them, which often means becoming acclimating to an engineered and constructed (e.g., urban) environment. Projecting that animals can potentially adapt to the same environment, via neuroplasticity, is only in a benign sense "anthropomorphising" them — suggesting otherwise would mask how much for humans too it is neuroplasticity and adaptation which enables us to experience constructed environments as "second nature." There is no reason to believe that our cognitive dispositions, shaped by our environments, evolved to mimic the world around us any less than that of animals'.

Indeed, ethnolinguistic research suggests that cognitive schemata implicit in language will vary among communities with noticeably different lifestyles (nomads versus city-dwellers, say), differences that can be detected in linguistic patterns (spatiotemporal markers in some indigeneous peoples' dialects, for example, where the relevant language-community is closely tied to a specific geographic area — whose natural features form a day-to-day backdrop encoded in language — function notably different than modern English, say) [39, page 141]. Neither genre of cognitive schema should be considered "true" to human nature; instead, we possess adaptable intellects that evolve to prioritize certain forms of mental representations over others, depending on what we need to function in our present environments. Guessing that the same holds for animals is not "anthropomorphising" them; it is instead making a credible generalization or extrapolation — from reasonable theories of how *our* cognition works — to other animals, or at least other mammals (who after all are relatively close to us in terms of evolutionary/genetic distance).

Data about individual dogs' abilities perhaps remains somewhat sporadic at this point because different researchers employ different methods. Gregory Berns is focused on fMRI scans and in general derives cognitive models from apparent brain activity, while Brian Hare assesses reasoning through problem-solving activities. John Pilley communicated with Chaser by talking to her, whereas Stella and her people communicate back and forth through talk buttons. The contexts and protocols in each case are different. Pilley demonstrated that Chaser had (comparatively) advanced language skills (or perhaps more appropriately cognitive abilities that lay at the foundation of language) — not just knowing many names for toys — because, for one, Chaser could react to noun-categories and not just single names. She could, for instance, "get the ball" — properly locating one toy matching the category — similar to but at a more abstract level than fetching a toy referenced by its unique name. Chaser also understood different verbs; she would at Pilley's request "nose", "paw," or "get" objects, each word corresponding to a different action on her part. Obviously Chaser therefore understood two-part phrases.

Evidence of Stella's understanding is different, because Hunger taught her a variety of words spanning different categories and uses, rather than a very large number of words with similar semantic profiles (like proper names). One question for dog-cognition researchers is presumably how to synthesize multiple experimental protocols, accepting that it can take a long time to acclimate dogs to specific kinds of communication and activity, so they probably can't just be layered together haphazardly.

Still, is seems plausible to generalize from examples such as Chaser and Stella so as to form a broader picture of dogs' potential language-understanding, construing observations from individual dogs like patches in a collage. If we consider, in particular, Berns's neurological studies, any dog's linguistic capabilities are presumably rooted in brain-states that are not significantly different between different individuals — It would be implausible to argue that Chaser, Stella and Bunny are black swans whose "experiments" present no ideas that could be generalized further. Any cognitive capability of one dog has to arise from a neurological architecture presumably shared, modulo subtle details, by the whole species. Any dog's nature is an intrinsic embodiment of what is biologically possible.[24] Only recently have dogs cohabitated with people to the degree seen in (at least urban, first-world) households, suggesting that this arrangement also incubates latent canine intelligence, particularly that derived from observing and interacting with people.

Talk of animals adapting to "urban" environments usually refers to non-domesticated birds or mammals that learn to build nests or burrows and find food in urban landscapes, but of course here we're referring to how dogs living with people acclimate themselves to the accoutrements of modern human lifestyles, like riding in cars (or buses), living in apartments, visiting stores, and so forth. Over time dogs learn the routines necessary for them to accompany people about their day, even if this involves behaviors (like jumping into the back seat of a car) that would be bizarre in the "natural" world. Much of this learning presumably happens by watching people. If this is true, though, it means that intersubjective consciousness is a crucial part of dogs' neuroplasticity.

On this theory, dogs' cognitive schemata are highly subject-centric, in the sense that schemata are structurally organized around individual people — their kinaesthetic gestures, their thoughts and feelings, their belief-formation. Dogs, we might say — much like people — live their lives as a sequence of intersubjective episodes, recurring "stories" involving themselves and the people in their life: someone comes home, someone leaves, people cook and eat dinner, go to sleep and wake up, get sick and recover. If Stella observations can be generalized, dogs perceive the world through representations that are oriented around individuals (including themselves), projecting themselves into others' perspectives as a kind of epistemic expansion that transitions from inner experience to objective facticity. In phenomenological terms, dogs have an *epistemological* intentionality, triangulating with other minds

[24] As such, we can see the linguistic faculties apparently evident even in just a few dogs as latent possibilities which all dogs have to varying degrees, whether they are properly loved or laying in a crate by a conveyor belt soon to be euthanized (Benoit Denizet-Lewis, *Travels with Casey*, page 171 [12]).

to metastatize transient consciousness into (implicitly) propositional attitudes. Apparently stepping over Berns' estimation of its limits, we seem to have fair grounds for perceiving within dogs' intelligence the kind of interpersonal-propositional faculties Husserl theorized in works like *Experience and Judgment* and *Cartesian Meditations*: we can download the Husserlian system of collaborative intentional-facticity into our appraisal of dogs' cognition.

Analysis of animals' grasp of (for example) "object permanence" or "physical causation", or of intersubject phenomena such as joint attention and perception of others' belief-states, skew toward experimental psychology. This may be true for humans too, or at least especially young children (where experiments could take forms such as playing with toys where games are rigged to yield puzzle-solving or behavioral observations, or showing infants scenes which do or do not appear to violate physical norms, as adults understand them, and noting that babies stare more attently at counterintuitive goings-on; or, for older children, telling stories, perhaps with the aid of toys/props, and then asking questions) [38, pages 68-9, 156], [27, page 100], [48], [46], [47], [34], [17], [26], [13], [49], [28], [52], [7]. While doubtless informative, such experiments present the relevent "folk-physics" notions as intellectual faculties which one merely has to varying degrees, perhaps (or as if) hard-wired in the mind. From this perspective it is easy to rank different species based on innate smarts.

But such a psychology-based paradigm perhaps does not tell the whole story. Consider object permanence: consider moreover how cognition occurs *in the context of* empathic, nurturing, collaborative co-existence amongst people and/or animals who interact, communicate, participate together in unfolding situations. It is easy to speculate that shared situational understand carries over to how we experience objects themselves (in the sense of ordinary, inaminate, medium-sized physical things around us): the more we interact in the context of a chair, a ball, a toy, and so on, the more we instinctively factor in how the others perceive that object, which in turn probably "triangulates" that thing in our mind. It is not just a sense-impression, or a somatic intensity that only I experience. Awareness of other minds compels me to transition from experiencing objects as raw sensory aggregates to grasping their coherent behavior (and behavior-potentials), their perdurance as rational objects in others' minds and in the world that we share overall.

Our point here is not that we can reconstruct animals' cognition by some sort of metaphysical deduction, but that these observations suggest *instinctive* processes by which "theories" of other minds translates to an awareness of the world that we, under the influence of philosophical reflection, would deem rational (and appropriately pre-linguistic, *poised for* something like language). There is no reason to suggest that dogs contemplate ontological questions; but it *is* at least a plausible hypothesis that other-mind cognition compels dogs toward a form of world-awareness with structuration similar to what philosophers identify self-consciously as a groundwork for metaphysical analysis. In other words, experience of or reasoning through object permanence (say) perhaps emerges not so much as an intellectual faculty but as a by-product of other-mind awareness. This thesis seems entirely in sync with the idea of "distributed" or "extended" cognition [8], [2], [44], [51], [41], [1], [35], [16], [15], [29], [45]; that perception of an object is not a private sensory dance between an isolated mind and a static external thing, but an emergent reality within a total complex wherein other minds also are often present: it is *we* who cognize, not *I*.[25]

[25]Not to suggest (to be precise) that the functionalist orientation of "extended mind" hypotheses as formulated notably by David Chalmers and Andy Clark is identical to perspectives of "distributed" cognition, as if "extended" and "distributed" were synonyms. However, further development of the Chalmers arguments do seem to have expanded upon the former notion so that it overlaps more and more with the latter.

This is, we would argue, at least one route to begin formulating a version of phenomenology which recognizes "mind" more broadly than just *human* intellect. The idea of a non-anthropocentric phenomenology has impressive precedents, notably the volume *Phenomenology and the Non-Human Animal: At the Limits of Experience* [36]. Charles Brown's chapter here is noteworthy in tieing intentionality to ethics, which would be an organic continuation of an other-mind/extended-cognition theory of intentionality such as we, implicitly, just sketched:

> Consequently, while the fundamentals of our moral psychology may start off as gut instinct, these basic proto moral sentiments are not just reactions to outside stimuli but have the quality of being directed to something or being about something. Empathy, for instance, is always empathy about something. Altruism, similarly, is aimed at the other. Moral sentiments are experienced by humans not as "raw feels," or unstructured qualia, but as referring to the other in an attitude of empathy. These are psychological-somatological moments that exhibit a pre-discursive intelligibility and a prima facie rationality. These social instincts, as Darwin refers to them, i.e., compassion, sympathy, and feeling, are not simply Humean impressions (as Darwin seems to think) but display an intentional structure that provides or denies justification of the lived sense of that experience. [5, page 88]

Even scholars whose methodology leans psychological rather than phenomenological seem to agree that dogs' interactive dispositions — closely observing humans, sharing human space to a degree which we can without hyperbole surely describe as unique among all non-human animals — lies at the heart of canine intelligence. It is not a radical further step to suggest that inter-subjective situational awareness, as it evolves and gets refined in animals' minds (and probably humans too), can in turn mold cognitive attitudes and dispositions (see also [22], [10], [31], [32], [30], [42], [6]).

Such a paradigm, if pursued, would involve in particular approaching canine experience from the perspective of (propositional) *intentionality*, not just conscious experience in general, which would also influence how we appraise dogs' feelings and desires. No-one questions, for example, that dogs appreciate human affection and value their caregivers.[26] Subjectively, then, we can certainly imagine how a dog feels reassured and joyful in the presence of an affectionate person (after all, we ourselves have a comparable experience in the presence of the dog). Such positive emotion, however, is relatively undifferentiated. Properly respecting dogs' intelligence implies that we should model dogs' comportment to their humans as more detailed than *merely* experiencing people as a zone of positive energy. Dogs don't just settle into our presence and feel good; they observe our behaviors and often learn to mimic them.

Watching people and figuring out how to insinuate themselves into human activity positions dogs in a context of treating human behavior as a kind of puzzle to be structurally resolved, not just the habits of protectors to be experienced emotionally. Dogs, that is, have to observe people as individual subjects operating in situations whose pragmatic and epistemic formations can be organized around them, potentially and perspectivally.

Doubtless the emotional bonds between dogs and their people add weight to their interest in the latter, so that the underlying emotional

[26]Berns's research, in particular, showed that reward centers in dog's brains responded as or more intensely to their "owner"'s kind words as to treats [4, page 150].

experience plays a motivational role in focusing attention. It is because Stella cares about Jake and Christina, for example (we could speculate) that she watches them with special emphasis, which in turn allows her to perceive the situations *she* observers from *their* perspectives as well. But if the onset of these motivations is emotional, the end-result is cognitive schemata which are structurally organized around human beliefs and behaviors, rather than the less "propositional" experience of love, hunger/thirst and satiation, play/boredom, and other basically somatic modes of consciousness which we might instinctively assume form the majority of canine experience.

Moreover, it is hard to image that Stella would learn to communicate at the level that she did without acute observation of the people she ended up talking to. Her linguistic capabilities piggybacked on her ability to form mental models of situations from different perspectives (her own plus others). Language is not only structured around cognitive schemata; it is structured around schemas whose organizing principle is the configuration of situations around each individual person, and our empathic/interpersonal ability to migrate orientation from person to person so as to understand situations collectively. We would argue that on these terms intersubjectivity grounds the two other foundational structures of language we have endorsed here (following the paradigms of Cognitive Grammar as we read them), namely situational understanding and conceptual plasticity.

4 Conclusion

Confirmation bias manifests itself in different ways. While scientific consensus should not be casually flouted, this maxim does not legitimate bias *in favor* of a status-quo. Skepticism should be balanced, prepared to question counter-paradigmatic arguments but also to flag when hypotheses may be perpetuated more by force of habit than substantial supporting evidence. Gregory Berns, Brian Hare, and Juliane Kaminski are leading dog-cognition researchers, but even amongst their writings we believe we can find conclusions that are counter-indicated by plausible evidence from talking-dog videos, some of which we have tried to briefly mark in this chapter (more detailed analysis/counter-argumentation remains a project for future research).

Even dog-loving experts such as Berns, for example, have proposed (in the recent past) that dogs do not associate their names with themselves. Stella and Bunny videos dramatically suggest the opposite: they both on occasion sound out their name in consort with follow-up behaviors that would be hard to explain *without* assuming that they know what "Stella" and "Bunny" means. At some level we reach a threshold where perpetuating older assessments of dogs' limitations carries *less* evidential warrant than revising them. This applies to self-awareness, and also, quite probably, to issues such as whether dogs understand noun/verb distinctions or multi-word phrases.[27] Ranking video observations via measures such as deliberateness, interpretive confidence, situational appropriateness, and follow-up behaviors is an example of methodological protocols that would guard against biases both *pro* and *contra* the status quo.

[27]Granted, we might speculate that some dogs are more inclined to "learn" human language. It is often said that *canis familiaris* shows a wider morphological range — not least size-variation — than any other species on the planet (amongst adult individuals), and some dogs are faster than others, stronger, more or less interested in different activities (fetching, chasing, herding, guarding), so it seems to reason that there could be similar variation in dogs' ability or motivation to mimic human speech. It is still an important scientific insight, however, if we accept that only a small percentage of dogs can achieve a level of linguistic understanding comparable to Bunny or Stella. Dogs who may not evince linguistic intelligence presumably focus their attention elsewhere (as with people, less proficiency in one area may be balanced by more proficiency somewhere else). A therapy or seeing-eye dog probably reveals equal intelligence to Stella and Bunny, but in their own line of work, no less than a Hadza hunter with spears and arrows is equally expert in his metier than urban professionals in theirs.

A final methodological point is that "dog communication" research does not need to show dogs' formulating phrases according to the rules of *proper* language as such (with multiple parts of speech — not just verbs and nouns — and morphosyntactic patterns). Probably no-one expects dogs to reproduce the complex system of syntactic interconnectors in natural language, and this would be infeasible via AAC buttons anyhow. For example, Stella's "beach inside" — referring to an inflatable boat and toys they take by the ocean being in the living room — implies a perceptive and situation-appropriate blend of concept in her mind. It is not especially important that she uses "beach" metonymically for things encountered *on* the beach, rather than devising a more intricate phrasal complex to orient her discourse toward beach-related objects rather than the beach itself.

Those questioning whether dogs are literally "talking" perhaps infer that some people are attributing to dogs linguistic competence at that quasi-human (adult) level. The reality is perhaps more interesting: such research gives us a window into how situational understanding and conceptual aggregation (*beach inside*, say, or *stranger paw*) yields proto-linguistic potentialities that can be analytically separated from the complexity of language's surface-level structures — wherein discursive articulation explicitly presents concept-connections that may be merely implicit in shared mental models. Thus "toy inside" depends on mutual understanding to convey *which* toy and *where* inside, and why, compared with how a person might express it ("I want to take the toy I just found inside the house").

Apart from the animal-cognition dimension, then, research into talking dogs deserves attention from linguists proper because it helps separate prelinguistic cognition from lexico-syntactic processing. This applies to parts of AI as well, such as Natural Language Processing. To the degree that dogs communicate via AAC buttons, their abilities lie in joint attention and habitual, situational collaboration with people, rather than by commanding large-scale vocabularies or inferring complex parse-graphs. Compared to computational NLP systems, dogs' linguistic processing appears to emerge from their shared *umwelt* with people rather than from innate abilities to master discursive, lexical, and morphosyntactic conventions.

If this analysis has merit, it should reinforce our skepticism that robots or AI could be engineered to understand human language, at anything less than a partial and superficial (albeit perhaps still quite useful) level. Robots, for example, cannot have (we may reasonably claim) interpersonal experience analogous to the shared affection between people and dogs, and therefore cannot have that underlying communal awareness which becomes leveraged in understanding "other minds." In this sense robots appear to lack an essential ingredient — perhaps *the* essential ingredient — in the emergence of human language. This does not foreclose some level of human/robot communication, because we already intimated through talk of "mid-level" language that a robot's discourse probably would not be human language in any case. But it does mean that the architecture of meaning and practical action which serves as structuring principles for robots' "language" need to be conceived against a foundation notably divergent from the foundations of human language.

4.1 Robotics and Environment-Models

If human language is not a reliable basis for human/robot communication, what should be the source for potential theories of "languages" appropriate for robotics? Here, research into dogs' communication with people can perhaps provide one crucial insight: our ability to

interact at some linguistic/gestural level with dogs depends on a significant overlap between dogs' and humans' models of their shared environment, which in turn get leveraged for communicative intent. If this analogy may carry over, any human/robot language would have to be grounded in robots' "perceptual" models of their environment, which in turn humans have to implicitly understand so as to orient robots' actions in context.

A significant part of most robots' understanding of their environment, of course, comes from visual processing, which would involve algorithms such as those touched on in Chapter 22 (e.g., for feature-detection and image-segmentation). Robots' models of their surroundings would need to start with preliminary object-detection — recognizing where there are discrete physical objects that can be studied and potentially moved or manipulated, perceptually distinguishing such potential foci of attention from the background environment — but apart from just *spatially* individuating objects robots have to estimate their physical properties (which objects, or parts of objects, can be moved, for example, and in what directions).

Robots' environment-models need not be completely open-ended; typically robots are built for specific tasks in specific kinds of environments, so it is possible to anticipate what *sorts* of objects robots are likely to encounter. In this sense they are not making inferences about external objects' behavior based *only* on visual input, but can be presupplied with data structures summarizing environing objects' properties and affordances. The interplay of robots' visual perception and their leveraging such *a priori* data then yields a correlation between spatial and function-organizational analysis similar to the cases examined in Chapter 20. That is, by combining spatial perception with preliminary data structures modeling categories of external objects, robots can develop hybrid environmental-models that combine spatial perception — which situates objects and movement-affordances in surrounding space — with profiles of objects' functional connections, which in turn would guide a robot's behavior and tasks to complete.

The examples in Chapter 20 considered analogous spatial/functional hybrid models such as Industry Foundation Classes (IFC) in the Architecture, Engineering, and Construction (AEC) context. IFC data (at least for many kinds of objects) combines CAD-oriented assets which model AEC artifacts visually and spatially, so that IFC object-collections underlie blueprints and/or 3D models of buildings, building-interiors, and other archictected sites. At the same time, IFC objects can be aggregated to provide functional models of buildings as organized systems, so as to assess their usability (from the point of view of their residents/occupants), risk-mitigation (in terms of, say, fires, floods, contamination, and other environmental hazards), or energy efficiency/carbon footprint. Such analyses are outlined more completely in Chapter 20; in the present context we simply want to point out that system-functional models are in this context tied together with spatial representations, such as CAD-based 3D scenes or 2D floor plans. A similar integration can inform systems where spatial representation is not a matter of *designed* space, intended to visualize architectural/engineering plans, but actual space where robots are situated.

Consider a robot equipped with data structures conformant to IFC or similar (modeling) protocols. Upon perceiving an object (which it sees and/or physically contacts) we can imagine the robot matching its shape, color, and related apparent qualities to a database of object-profiles, presumably matching the perceptual inputs to a class or category with an IFC-like description. Such a description, in turn, would offer both a 3D model of the object's geometry/kinetic properties (how the object moves holistically and its parts move relative to each other) and schematic data aggregation specifications related to the objects' materials, manufacturing, physical attributes (such as weight, density, fragility), and other information that would be relevant to robots' instructions. If an object is a piece of industrial equipment, for example, the IFC-like data could include part/model numbers and industrial specs; a robot might be programmed to test (and notify human monitors) if a part appears to be damaged.

The functional/spatial convergence evinced by formats such as IFC can be taken as an intuitive example of the environment-models through which robots could operate. Insofar as functional/spatial hybrids may likewise be represented through computer applications and GUIs, we might assume that users guiding robots could similarly access views of robots' environments with analogous functional/spatial duality — e.g., a user through a robot's visual feed would see a 3D scene (embodying spatial data) and then select visible objects to examine through data-presentation windows (transitioning to functional-organization style data). In this sense users and robots can synchronize their respective views on robots' environment, which, inspired by animal (or at least dog) cognition research, we should take to be the crucial first step toward communication.

On these considerations, we believe that a prerequisite for effective human/robot communication would be well-organized GUI systems representing robots' environments *for* human users, where GUIs encompass components for viewing both spatially-articulated data (video/camera feeds, 3D scene models, etc.) and functionally-oriented summaries of objects' industrial, physical/kinetic, environmental, or project-specific attributes ("project-specific" in the sense that robots typically interact with objects manufactured to collectively form a physical system engineered to specific ends; analogous to machines, but on the scale of a complex whole, such as a factory, building site, environmental cleanup operation, etc.).

Such observations are just a starting point, of course; further analysis of these proposals would need to address how human users should view and interact with robots' environments. We will return to this issue in Chapter 24.

From this chapter's perspective, the key foundation of linguistic communication is shared situational and "environment" models. Looking beyond human language proper, we can see clear evidence of human communication with animals, so long as both parties' mental models are in sufficient synergy. To say that Stella *talks to* Jake and Christina (and vice-versa) is not a metaphor or exaggeration; albeit with the aid of a mechanical device based on AAC tools (that some people also use), Stella and Bunny are *literally* "talking dogs." Their use of buttons is too sophisticated to be equated with performing tricks or enacting gestures (as if the sound produced by talk buttons were proxies for nonlinguistic gestural communication), given how they strings words together, initiate talk in contexts other than requesting something specific like a treat or a walk (e.g., when she is expressing affection, or commenting on what is happening around her), and almost certainly regard their ability to employ human language as a source of agency and connection to their human friends.

None of these inter-subjective phenomena belong in models of human/robot interactions, but we can still talk of humans and robots sharing environment/situational awareness, which could potentially lay a foundation for (at least something like) a common human/robot language.

Humans and robots can share mental models of an "environment"

because robots are specifically engineered to simulate the intelligent and semi-autonomous behavior of animals (in that robots typically process inputs visually and/or tactilely, and are able to move around or reposition their physical configuration, often without explicit guidance). Most computational systems are not equipped with analogous capabilities, so the picture of humans communicating with computers through *language* becomes more strained or analogic when we go from robots to computers in general. Certainly when interacting with familiar desktop computers it is only in a highly metaphorical sense that humans and computers "share" common mental models. Nevertheless, although joint awareness is a foundational prerequisite for language proper, there are other syntactic and semantic structures which emerge on that foundation, and there is some merit in treating computer programming languages as instantiating at least some of these linguistic patterns, in some (not entirely metaphorical) sense. The specific details of how computer languages might borrow structures from language proper (even if, as we claimed at the start of Chapter 20, we should not take literally the convention of calling the dialects of computer code "languages," even artificial ones) is a theme that will be taken up in greater detail in Chapter 24.

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