

CS 6795 Introduction to Cognitive Science

Spring 2012 Homework Assignment 2

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14th February, 2012

Assignment

Like the evolution of physiological traits, the evolution of cognition has begun to be understood as a process that unfolds over time and is influenced by the pressures of natural selection and survival. Along with such a view comes the question about whether the immense complexity and capability of human cognition is just a continuation of the kinds of cognition found in other animals, or whether, somewhere along the evolutionary road, human cognition has undergone a step change that makes it fundamentally different in some way. The paper "Darwin's Mistake: Explaining the discontinuity between human and nonhuman minds" takes one particular stance on this issue. For this assignment, you will need to read the target article and at least two of the open peer commentaries (along with whatever portions of the final rebuttal might be relevant to the commentaries that you choose). Please write a paper of at least 1200-1500 words that summarizes the target article from a cognitive science perspective, summarizes each of your chosen commentaries, and presents "an open peer commentary" of your own on some aspect of this debate on the nature of human vs. non-human cognition.

1 Target Article Synopsis

In *Darwin's Mistake* (2008), Penn et al. begins with an exhaustive presentation of what is claimed to be a, “pervasive functional discontinuity between human and nonhuman minds,” and that this discontinuity lies in the method in which humans and nonhumans reason about relations. The authors begin with an exhaustive checklist of higher-level cognitive tasks and experimentation with nonhumans. The most consistent critique that Penn observes with the experimentation presented is a commonality in which much of what the original researchers ascribe to higher-order relational ability is actually a creative observation by the subject of a first-order relation or physical observable difference that the experimenter has overlooked.

Penn et al. describe a hypothesis they subscribe to, known as the physical symbol system (PSS) hypothesis (Penn, 2008). The PSS provides a computational account of how humans are able to generalize rule-like relations, to reason in an inferentially coherent manner, and to use artificial symbols of a natural language systematically, recursively, and generatively. Due to the inherent flaws of the PSS hypothesis, Penn describes an alternative, the relational reinterpretation (RR) hypothesis. This hypothesis states that human minds are capable of all of the representational abilities ascribed by the PSS and nonhuman animals approximate some of these same abilities only to a lesser degree, or not at all (Penn, 2008).

The discontinuity between nonhuman animal's and human animal's abilities is said to result from the differing levels of an approximation of their respective relational capabilities of a PSS. In a way, human higher-order functional representations are said to have evolved on top of the proto-symbolic systems that we still share with nonhuman animals. A model called the Learning and Inference with Schemas and Analogies, or LISA, is said to show that the substantive difference between humans and nonhuman brains will be found in the prefrontal cortices (Penn, 2008). The authors then admit that no empirical evidence exists to directly support the RR hypothesis and that no biologically plausible model of nonhuman animals has been proposed by it. They conclude by stating that the most important claim of the article is that human beings alone have the ability to reinterpret the world in a symbolic-relational fashion (Penn, 2008).

2 Comparative intelligence and intelligent comparisons

Gardner et al. challenge the validity of Penn's claim to a discontinuity between humans and nonhuman animals. Their argument basically lies in three main points. The first point is that comparative psychology has been ridden with experimentation wrought with tainted data in which

the experimenter unknowingly provides cues to the nonhuman as to which selection to make. Although Gardner mentions Basso, a chimp who supposedly had the ability to do basic arithmetic, where the benefits of this experimental error seemingly provide evidence of a smaller gap in human-nonhuman cognition, one may propose cases in which the experimenter would sway the nonhuman subject to an incorrect response that would support Penn's hypothesis. Gardner claims that this experimental error is persistent in "virtually all of the experimental evidence that Penn et al. cite" (Penn, 2008).

The second point Gardner et al. makes is that that comparable conditions are required for credible comparisons. The nonhuman animals in Penn et al.'s cited experimentation are typically caged. Gardner notes that these caged animals, particularly chimps, that are caged tend to score progressively worse on cognitive tests the longer they are in them. Gardner then cites cases of cross-fostered chimps that lived in human homes and learned with human children in everyday communication. Gardner states that although growth was slower than human children, it was patterned and consistent growth that never reached an asymptote during the 5 year experiment (Penn, 2008).

The last point made by Gardner is that highly repetitive drill induces stereotypical habits that interfere with human and nonhuman problem solving (Penn, 2008). The tube-trap problem cited by Penn subjected their subjects to just such a repetition. Gardner also cites decades of evidence of the "mind-numbing effect of drill" and also of negative effects on human problem solving (Penn, 2008). Penn makes a rebuttal to Gardner stating that Gardner et al.'s argument can be reduced to a claim that human uniqueness is solely the product of human enculturation with no regard to the other two points listed (repetitive drill and experimenter cues) (Penn, 2008).

3 Bottlenose dolphins understand relationships between concepts

Herman et al. take on Penn's argument of functional discontinuity among nonhuman animals citing experimentation with large-brained bottlenose dolphins. The authors state that the dolphins were able to learn and understand an artificial language system of first-order relations (Penn, 2008). Without further training, the dolphin was able to spontaneously understand concatenations of first-order relations and infer higher-order relations, a feat said to be un-attributable to nonhuman animals by Penn. Herman describes an ability present in the dolphins that allowed for at-will reinterpretation of the relations between the symbols and the real world (Penn, 2008). Since the dolphins have an ability to mimic humans or other dolphins, Herman

argues that behavioral imitation is a form of similarity comprehension and may also require inferring an analogy when the imitation crosses species boundaries (i.e. a human leg becomes a dolphin's tail). Lastly, Herman states that Penn et al. reject that nonhumans can participate in collaborative efforts and Herman cites many examples in which dolphins are able to perform tandem behaviors nearly in perfect synchronization. The authors also make a note that the dolphins live in a stimulus-rich educational environment that may allow for intellectual competencies to arise that do not in the studies presented by Penn which do not foster such an environment (Penn, 2008). Herman et al. largely take the stance that each species must be examined independently and that Penn et al. have a less plausible position of a genetically pre-specified super-module.

Penn et al.'s defense against Herman begins with a claim that there is a misunderstanding of the term, "discontinuity," and that the authors were mistaken in a "rush to defend Darwin's honor" (Penn, 2008). Penn restate their claim that relational cognitive processes in humans are differentiated by a significant gap with nonhuman animals. Penn admits that their argument only pertains to extant species and that if every organism that had ever lived were still alive then no gap would be present. They again state that among extant species, humans alone have the ability to "reason about higher-order relations among relations in a systematic, structural, and role-based fashion" and go further to say that, "higher-order, role-based relational reasoning appears to be a uniquely human specialization" (Penn, 2008). Although no claim is made outright in Herman's commentary, Penn state that the dolphins never demonstrate, "the ability to process sentences involving hierarchically embedded constructs" (Penn, 2008).

Penn describes the evidence presented by Herman related to the tandem collaborative tasks as not demonstrating that dolphins understand each other's roles in a collaborative fashion or are capable of intentional communication. Penn et al. proposes instead a modified version of the tandem and create commands that may provide definitive evidence for role-based collaboration and intentional communication among dolphins. Penn also describes a "false belief" task which may be able to show that another species besides humans possesses theory of mind (Penn, 2008). It should also be noted that Penn describes the dolphins advanced behaviors as being a result of "intensive training" while Herman describes the most remarkable demonstrations performed by the dolphins (particularly the inference of higher-order relations) were demonstrated with no additional training whatsoever outside of the first-order tasks (Penn, 2008).

4 Further Discussion (Difficulties with “humaniqueness”)

Pepperberg discusses several outlying cases not addressed by Penn in the target article. One is a Grey parrot named Alex who has the ability to detect similarity and another is a great tit who can make transitive inferences without egocentric prediction. The author also points out a starling that can learn recursive, center-embedded grammar. In particular, Alex was able to make categorical distinction with items with a lack of variability and even with items with no variability whatsoever. Evidence is also said to exist which demonstrates that Alex understood number symbols could be abstract representations of real-world objects. Pepperberg’s primary argument seems to be that, although Penn demonstrate cases in which human and nonhuman capacities differ, there is a lack of data to support their theoretical stance. She also makes an excellent observation that more evidence to support a continuum has been found since the target article was written and thus future research is necessary to substantiate any related claim (Penn, 2008).

Penn et al. reiterate that a categorical understanding does not show evidence for higher-order relational reasoning as it is performed by humans. A distinction is made where Penn describe the operations performed as differing in kind (Alex is not performing the same kind of operation a human does). Penn also make note of the symbolic relational abilities of Alex and state that these abilities should not be underestimated. With regards to the great tits, Penn simply states that the experiments show no evidence that the great tits are capable of transitive inference and that they are simply keeping track of dominance relations of conspecifics. The primary argument against the starlings is that there is a lack of evidence that starlings can generalize the patterns into novel structures. Penn concludes by stating that Alex’s abilities are an example of what nonhuman species can accomplish through intensive training (Penn, 2008).

5 Open Peer Commentary

The author generalizes many of the introductory claims of lacking cognitive abilities in nonhuman animals and states that the given evidence is suggestive of a formative discontinuity between humans and nonhumans. This discontinuity seems present based only on the “evidence” presented by Penn in the target article, however, the critique is hardly complete without considerations given by other research such as that performed by Herman on bottlenose dolphins or Pepperberg on Grey parrots and starlings.

Herman describes the dolphin’s abilities to be analogical thinking, higher-order inferences of symbols as related to the real world, and collaboration (Penn, 2008). Penn’s rebuttal takes on all

of these with the exception of the higher-order inference. Penn states that the dolphins never demonstrate, “the ability to process sentences involving hierarchically embedded constructs,” (Penn, 2008) even though this straw man argument negates the other higher-order abilities claimed by Herman to exist within the dolphin’s abilities. This does not mean the dolphins are incapable of such tasks, and further experimentation is clearly required to make this determination. It seems that Penn et al. may be prematurely making these claims that all nonhuman animals are qualitatively distinct from humans when animals as capable as the bottleneck dolphins of Herman, or the Grey parrot of Pepperberg have yet to be experimentally tested for empirical confirmation. An address to the idea of prematurity is made in which Penn describes their postulation as a “possibility” that human cognition is unique even though their entire hypothesis is based around that fact (Penn, 2008). Penn et al. largely seem to disregard the experimentation presented by Herman et al. and the implications of the abilities demonstrated by dolphins.

Penn et al.’s underlying argument is merely a critique against the experimentation presented, since many of their claims are that data has been misinterpreted by the original investigator due to bias or other errors. This being said, a counter-claim can be made by Gardner whose investigation reveals that many of the experiments cited by Penn are ridden with experimenter bias wherein the researcher is in plain view of the subject. Gardner’s second point (that a comparable learning environment is necessary for true, and honest comparative research) is given support by Herman’s claim of a rich learning environment for the dolphins is key to their success and advanced cognitive ability.

There seems to be almost a provocation in the target article and in many of the responses to peer commentary. This may suggest that their true motive is, not necessarily provide empirical evidence to base the relational reinterpretation hypothesis, rather to elicit deeper understanding of the available data, promote more meaningful testing, and point out a need for less researcher bias. The functional claims made by the RR hypothesis seem valid, such as the abilities of humans to possess cognitive abilities as described by the PSS. However, there is some difficulty in accepting Penn’s claim that human’s abilities must be contained in the more developed frontal cortices, since as Herman points out, the large-brained dolphins are lacking and yet still seem to possess much greater ability than even higher primates cited by Penn. In this way, it is not very likely that Penn’s claims of a sort of evolutionary totem where humans are atop exists since these dolphins clearly reside on a different track with similar higher-order capabilities. I tend to agree with Pepperberg, in that the available data seems to suggest a continuum of behavior patterns between humans and nonhumans. A more reasonable and substantiated claim might be to say that all animals reside on evolutionary tracks, with most not having all of the cognitive abilities

ascribed to humans while some evidence exists to support continuity in ability. It is my opinion that Penn is correct that more evidence is needed and much further experimentation should be performed to confirm the speculation presented, however, the RR hypothesis is incomplete and not supported by the existing evidence presented here.

6 References

- [1] Penn, D. C., Holyoak, K. J., & Povinelli, D. J. (2008). Darwin's mistake: explaining the discontinuity between human and nonhuman minds. *Behavioral and Brain Sciences*, 31(2), 109-130; discussion 130-178. Cambridge Univ Press. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/18479531>