Trends in Cognitive Sciences

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Letter

Submentalizing Cannot Explain Belief-Based Action Anticipation in Apes

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Humans not only track each other's behavior but also make inferences about what others are thinking. An enduring question in cognitive science concerns the extent to which this theory of mind (ToM) is shared with nonhuman animals [1]. Adapting a seminal eye-tracking paradigm [2], we recently showed that humans' closest ape relatives (bonobos, chimpanzees, and orangutans) can pass a modified false belief test [3]. Specifically, apes looked in anticipation of an actor searching for an object where the actor had last seen it, even though the apes themselves knew that it was no longer there. These results provided the first evidence that apes may understand that others' behavior is guided not by reality but by beliefs about reality, even when those beliefs are false.

In response to this finding, and in line with previous arguments about the performance of human infants and adults in similar ToM tests [4,5], Heyes [6] has suggested that apes' success may not reflect ToM skills but rather more basic submentalizing processes. Submentalizing is 'prediction of behaviour by low-level, domain-general psychological processes' [6]. In particular, targeting Experiment 2 of our study, Heyes [6] proposed that, rather than encoding where the actors last saw the object before they left the scene (and before it was removed in their absence), apes may have encoded low-level properties like 'the appearance and disappearance of the [actor's] striking green shirt'. Then, during the test phase, the return of the green shirt could have served as a retrieval cue, eliciting a memory of the box that contained the object when the green shirt was last present. Similarly, 'the orientation of the green object relative to the boxes and the brick [the target object] prior to the green object's disappearance could have acted as a contextual cue priming the apes' visual search when the green object reappeared' [6]. To control for domain-general processes in ToM tests, Heyes [6] suggested the use of inanimate controls that maintain perceptual features but reduce the agentic qualities of the stimuli. If submentalizing is responsible for the results, participants should perform identically in inanimate controls as they do in social versions of the stimuli.

Although domain-general processes may be involved in nonhuman (and human) social cognition, such processes alone are insufficient to explain ape social cognition generally or our results specifically. First, submentalizing accounts rely on different domain-general mechanisms to explain behavior in each testing situation, and thus none can account for the consistent performances of apes across

Box 1. Inanimate Submentalizing Control

We presented apes with a nonsocial control of our previously published study [11] using identical methods except that, following [6] (Figure I), stimuli were animated versions in which the human actor was swapped out for a green semicircle and the King Kong antagonist for a grey triangle. The submentalizing hypothesis predicts that, given similar attention, retrieval and contextual cueing will elicit similar anticipatory looking patterns. In the control test, apes closely tracked all key events. However, unlike in the original study, only half of the apes looked to the boxes upon the return of the green semicircle. Moreover, unlike in the original study, among those apes that did make looks to the boxes, there was no significant tendency to look first (or longer) to the correct over the incorrect box, with a notably smaller effect size. Thus, the results from the control study do not support the submentalizing hypothesis.

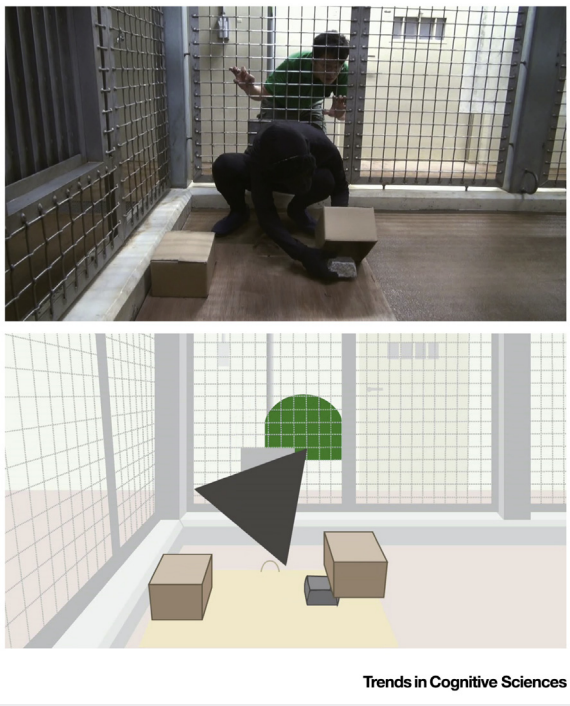

Figure I. Example frames from the original (above) and control inanimate videos (bottom). See control video online (https://youtube/J9hJBLcHc2A).

diverse ToM tests [7]. Specific to false-belief attribution, such evidence even includes the recent finding that apes might understand an experimenter's false beliefs in an interactive helping task [8]. Second, in an experiment based on an earlier proposal by Heyes [5], Karg *et al*. [9] showed that chimpanzees could apply previous self-experience with the occlusive properties of two barriers (i.e., that one was opaque and the other see-through) to determine which path would allow them to steal food from a competitor without being seen, even though at the time of choice the barriers appeared identical and no low-level cues were available to the participants.

Finally, submentalizing could not explain the anticipatory looking of apes in a previous eye-tracking study in which an inanimate control was implemented. Kano and Call [10] tested great apes with movies in which a hand repeatedly reached for and grasped one of two objects. When the locations of the objects were switched and the hand moved centrally toward both, apes looked in anticipation of the hand pursuing a new path to grasp the old goal. However, when watching videos that were identical, except that the hand was replaced with an inanimate mechanical claw, apes looked to both objects equally. They did not anticipate that the claw would pursue the old goal, as they did in the case of the animate agent. Thus, inanimate features of the stimuli could not account for the goal-based action prediction of apes.

In spite of this evidence, we accepted Heyes' [6] challenge and performed an inanimate version of the false-belief task that was highlighted in the author's article. Despite comparable levels of attention, the inanimate stimuli elicited markedly lower anticipatory looking and no significant tendency to look to the correct box (see [11] and Box 1 for a summary). Thus, evidence from diverse studies – experience–projection, interactive helping, and inanimate controls of implicit goal-understanding and false-belief attribution tasks – converge on the same conclusion: submentalizing is insufficient to explain the social–cognitive abilities of great apes [7–10].

Acknowledgments

We thank Dr. Cecilia Heyes for discussing the details of our nonsocial submentalizing control experiment reported here.

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http://dx.doi.org/10.1016/j.tics.2017.06.011

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