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African elephants interpret a trunk gesture as a clue to direction of interest

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Orienting to gaze-direction is widespread among animal species, but evidence for spontaneous use of gesture for direction is limited [1]. Remarkably, African elephants (*Loxodonta africana*) have been found able to follow human pointing, including subtle actions in which the contralateral hand is used, and in which the body silhouette is not broken [2,3]. The natural origin of this ability is puzzling, as the species is not reported to use trunk- or limb-gesture for showing directions [4]. One natural gesture, the 'periscope-sniff' presumed to be used to enhance olfactory sampling by an elephant in circumstances of alarm or curiosity [5], might also betray the elephant's direction of focal attention. Here we investigate what information elephants gain from seeing periscope-sniff. When one elephant in a group gave a periscope-sniff, we recorded the location and orientation of the next periscope-sniff given. Elephants that could not see the first gesturer only gestured themselves if immediately adjacent to the first or closer to the presumed stimulus of interest. In contrast, elephants able to see the first signaller's periscope-sniff were often a considerable distance behind it, further from the stimulus. Focusing on these cases, where making the periscope-sniff was apparently caused by seeing the first gesture, we found its orientation significantly matched the first, suggesting that direction information was gained from seeing the periscope-sniff. Elephants' ability to use a conspecific's periscope-sniff as if it were an

ostensive pointing gesture enables them to react to the presence and location of potential dangers.

The African elephant is a highly social species [6], in which most individuals live long-term in matriarchal groups composed of several generations of related females and their calves; older males may associate with these family groups, travel alone or with other males. Vulnerable young calves receive protection from all adult females in their group, and adults are highly alert to the potential presence of predators or other risks [7]. When an individual detects any unexpected stimulus, the typical reaction is to make a 'periscope-sniff' gesture (Figure 1), defined as "lifting trunk up in an s-shape to detect scents carried on the wind; particularly used when meeting strangers, potential dangers or if additional information is required" [5]. Although the primary function is apparently to enhance olfaction, the form of the periscope-sniff gesture indicates (to human observers) the fact that the elephant is somewhat concerned and the approximate direction of the stimulus that has alerted it. We recorded the sequelae to an elephant giving the periscope-sniff gesture, in order to study whether other elephants gain information from seeing periscope-sniff.

We video-recorded groups of elephants, and analysed bouts in which several elephants showed the periscope-sniff gesture. When one elephant in a group gave a periscope-sniff, we recorded the location and orientation of subsequent periscope-sniff gestures given by others as a measure of the spread of awareness of the stimulus of interest or alarm. We took it that the first to gesture did so in reaction to an environmental stimulus of some kind: often a likely stimulus of interest was evident. We focused on the second elephant to show periscope-sniff, which might have been in reaction to seeing the first elephant's periscope-sniff gesture. Videos were analysed for the distance between first and second gesturer (in terms of intervening individuals), distance of each from the presumed stimulus of

interest, and whether the second elephant was physically able to see the first make its periscope-sniff gesture.

To model the pattern of responding, we found that it was necessary to consider whether the next elephant to respond had clear line-of-sight to the first, as well the distance between them. Model selection using an Akaike information criterion (AIC) and generalised linear models (GLM; see Supplemental Information) showed that the best-fit model contained the terms 'Distance between elephants' and 'Able to see first gesturer' (Table S1). The influence of proximity was anticipated, since the first elephant to gesture must be able to detect the stimulus of interest, so elephants adjacent to it are a priori likely to be able to detect the stimulus by olfaction, sight or hearing.

We found that the pattern of responses differed according to whether the second elephant to gesture could have seen the first. When the line-of-sight between first and second gesturer was occluded, the second elephant to gesture was always adjacent to the first or closer to the stimulus of interest than it, as expected if it detected the stimulus independently. When the second elephant to gesture was physically able to see the first's gesture, we found a very different pattern: in many cases the second gesturer was behind the first, often by a considerable distance, and further than the first from the actual stimulus of interest. Indeed, in two-thirds of cases, three or more elephants intervened between the first and second to gesture (Figure S1): in principle, some of these elephants might have detected the stimulus independently, yet no such detections occurred in elephants lacking clear line-of-light to the first gesturer. Focusing on these cases, we found the orientation of the second elephant's periscope-sniff gesture consistently and significantly matched the direction of the first (93% same). We conclude that witnessing a periscope-sniff gesture may reveal both the presence and direction of a stimulus of potential concern or interest to other elephants, enabling them to react appropriately without need to detect that stimulus for themselves.

We found no evidence in this study that the periscope-sniff gesture is made intentionally to communicate [8], as a deliberate pointing gesture. Rather, we suggest that a gesture, whose primary function is enhanced olfactory sampling, can be 'read' distally by other elephants as a signal of the presence and direction of some stimulus of potential significance [9]: functional pointing, not ostensive pointing (see Supplemental Information). The ability that enables African elephants to profit in this way under natural conditions may explain their remarkable aptitude in captivity to interpret human pointing correctly, without explicit training in use of any human gestures [2,3].

Supplemental Information

Supplemental information includes one figure, one table, and further details of experimental procedures, results and analysis, and discussion, and can be found with this article online at *bxs.

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Declaration of interests

The authors declare no competing interests.

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Figure 1. African elephant showing 'periscope-sniff' gesture (R.W. Byrne).

Supplemental information

Document S1. One figure, one table, and further details of experimental procedures, results and analysis, and discussion.

In Brief

When alarmed, African elephants make a gesture, periscope-sniff, whose primary function is olfaction. Smet & Byrne show that others interpret this gesture as "functional pointing", using it to locate the direction of another's interest. This may explain how elephants can interpret human pointing without any training, an ability rare among animals.