Research Article



# Agent Preference in Chasing Interactions in Guinea Baboons (*Papio papio*): Uncovering the Roots of Subject–Object Order in Language

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#### Abstract

Languages tend to describe "who is doing what to whom" by placing subjects before objects. This may reflect a bias for agents in event cognition: Agents capture more attention than patients in human adults and infants. We investigated whether this agent preference is shared with nonhuman animals. We presented Guinea baboons (*Papio papio;* N = 13) with a change-detection paradigm on chasing animations. The baboons were trained to respond to a color change that was applied to either the chaser/agent or the chasee/patient. They were faster to detect a change to the chaser than to the chasee, which could not be explained by low-level features in our stimuli such as the chaser's motion pattern or position. An agent preference may be an evolutionarily old mechanism that is shared between humans and other primates that could have become externalized in language as a tendency to place the subject first.

#### Keywords

agent-patient, thematic roles, event cognition, language evolution, linguistic universal

Received 5/15/24; Revision accepted 4/25/25

Human languages vary greatly at all levels of description yet also share several important commonalities (Greenberg, 1963). For instance, in 97% of languages with a dominant word order, the subject precedes the object (Dryer, 2013), such as "the girl [subject] pushed the boy [object]" in English or "larki-ne [subject] larkeko [object] dhakka diya" in Hindi. These cross-linguistic statistical regularities have been the topic of many inquiries in the cognitive science of language, but their origin remains a topic of ongoing debates (Chomsky, 1957; Culbertson et al., 2020; Evans & Levinson, 2009; MacWhinney, 1977). Statistical universals may be the product of language contact and history (Dunn et al., 2011) and/or reflect evolutionary processes that are independent of cognition (Bybee, 2006, 2009; Gibson et al., 2019; Kirby et al., 2008). Another possibility is that they are the result of cognitive biases and mental representations that preexist language (Culbertson & Kirby, 2016; Martin et al., 2024; Strickland, 2017). For instance, the tendency for word orders to prioritize subjects before objects may originate from the way humans naturally process events around them, with a preference for attending to agents (typically mapped to subject positions) before patients (typically mapped to object positions; Jackendoff, 1999; Ünal et al., 2021). Such an agent preference (i.e., a prioritized attention toward agents when observing events) has been argued to have deep evolutionary roots beyond human language (V. A. D. Wilson et al., 2022; Zuberbühler, 2019, 2020, 2022; Zuberbühler & Bickel, 2022).

The strong link between linguistic event descriptions and event cognition supports this theory (Rissman & Majid, 2019; Ünal et al., 2021). Although reflected as

Psychological Science 1–13 © The Author(s) 2025 Article reuse guidelines: sagepub.com/journals-permissions DOI: 10.1177/09567976251344581 www.psychologicalscience.org/PS



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specific arguments in active transitive sentences, the underlying conceptual structure is thought to be more general: The agent (doer) causes an action that affects the patient (undergoer; Fillmore, 1968; Jackendoff, 2002). Furthermore, the agent and patient are often characterized by features that are associated with their role, such as the agent's volitional behavior, awareness, motility, and independence, whereas the patient is defined by its reliance on the agent, undergoing change, and being less dynamic (Dowty, 1991). It follows that attributes such as agency (intentionality and goaldirectedness) and animacy (being alive) are applicable to both roles, but they are more likely to be associated with the agent role. Even though speakers can use linguistic devices to highlight any argument by placing it first (e.g., the patient in passive structures), placing the agent in the subject position appears to be the default (Bickel et al., 2015; Gertner & Fisher, 2012).

Evidence that agents and patients can be represented in an abstract sense comes from experiments demonstrating the saliency of these roles, and in particular agents, over a wide range of events, such as pictures, drawings, and even animations with two-dimensional shapes. Not only do human adults spontaneously and unconsciously extract event roles from brief visual events (Hafri et al., 2013, 2018), but agents also attract their attention more than patients. While watching events, human adults first direct their gaze toward the agent of an action (Webb et al., 2010). Similarly, in cartoons, agents are looked at longer than patients (Cohn & Paczynski, 2013), and from short displays of drawings, agents are systematically better identified than patients, instruments, and actions (Dobel et al., 2007). Furthermore, adults are faster to orient to agents when asked to detect agents than to orient to patients when asked to detect patients (F. Wilson et al., 2011).

Developmental studies suggest that this agent preference is not the result of linguistic experience with subject-object ordering. Seven-month-old preverbal infants use postural and positional cues to assign agent and patient roles in an abstract way (Papeo et al., 2024). When presented with 2D chasing interactions, 5-monthold infants look more toward the chaser than the chasee (but not toward the leader in a following interaction; Galazka & Nyström, 2016) and thus show an attentional preference for chasers similar to human adults (Meyerhoff et al., 2014). In 9-month-old infants, looking at the chaser evokes neural responses related to social perception, suggesting that the chaser may be perceived as an animate entity (Galazka et al., 2016). This bias toward the agent also appears to be reflected in word learning; 14-month-olds learn a label for a chaser more easily than for a chasee (Yin & Csibra, 2015).

Although an agent preference is thus found under nonlinguistic conditions, its evolutionary origins remain a mystery. One possibility is that an agent preference can be found in nonhuman animals. This would suggest that the structure of event representations has an old evolutionary history and may form the roots of one of the key characteristics of human language: its subjectobject word order. Alternatively, an agent preference could be a typically human bias that has evolved concurrently with language (V. A. D. Wilson et al., 2022). The evidence for an agent preference in nonhuman animals so far is not conclusive. Although nonhuman animals can detect some cues indicative of animacy (Hauser, 1998; Rosa-Salva et al., 2016), less is known about how nonhuman animals use the relational aspect of an interaction to identify agents versus patients. Great apes (chimpanzees; Pan troglodytes), gorillas (Gorilla gorilla), and orangutans (Pongo abelii) scan videos of dyadic event scenes similar to how humans scan them, with their gaze alternating between the agent and the patient, but an agent preference has not been observed in any of the species (including humans; V. A. D. Wilson et al., 2023). At present, it thus remains unclear whether nonhuman animals also show an attentional bias for agents versus patients.

Here, we investigated the evolutionary origin of the agent preference in Guinea baboons (Papio papio). Baboons share a common ancestor with humans that lived 25 to 30 million years ago. They have evolved under similar environmental conditions as humans (Fischer et al., 2019), making them a good model species for language evolution (Fagot et al., 2019), especially with regard to possible roots in social cognition (Seyfarth & Cheney, 2014). To test an agent preference in Guinea baboons, we studied their response to generated animations of chasing interactions in which the agent and the patient were represented by two identical, simple geometrical shapes. Although it is debated whether monkeys attribute mental states to 2D shapes (Schafroth et al., 2021), forms similar to ours have been repeatedly used in previous studies that revealed that chasing can be discriminated from other motion patterns by human adults (Abdai et al., 2017; Atsumi et al., 2017; Barrett et al., 2005; Hofrichter & Rutherford, 2019; Meyerhoff et al., 2014; Rochat et al., 1997), human infants (Frankenhuis et al., 2013; Rochat et al., 1997), and several nonhuman species, including dogs (Canis familiaris; Abdai & Miklósi, 2022; Abdai et al., 2017), cats (Felis silvestris catus; Abdai & Miklósi, 2022), rhesus macaques (Macaca mulatta; Atsumi et al., 2017), squirrel monkeys (Saimiri sciureus; Atsumi & Nagasaka, 2015), and pigeons (Columba livia; Goto et al., 2002).

We presented baboons with a change-detection task on a touch screen in which the participants had to



**Fig. 1.** Experimental setup. In our (a) chasing change-detection task, a fixation cross appears first that has to be touched by the participant. An animation with moving objects is then generated. Depicted here are two objects involved in a chasing interaction. After a certain period of time, one of the objects will change color. On the top row the agent changed color, and on the bottom row the patient changed color. The changed object requires a touch response that subsequently results in a food reward, as shown by the dotted line (top). Any other touches result in a 3-s time-out screen (bottom). Also shown is (b) a participant taking part in the experiment.

respond to a color change to either the agent or the patient of a chasing interaction (see Fig. 1). The rationale of this procedure is that areas that attract attention are prone to faster change detection than less attended regions (New et al., 2007); a similar method using dotprobe tasks has been successfully applied to nonhuman primates (van Rooijen et al., 2017). We preregistered the prediction that if baboons show an agent preference such that the chaser captures their attention more than the chasee as in human infants and adults (Galazka et al., 2016; Meyerhoff et al., 2014), they should be faster to detect the color change applied to the chaser than to the chasee. Response time is indeed a widely used measure to test an agent bias (e.g., Hafri et al., 2018; Meyerhoff et al., 2014). We additionally tested accuracy with the same predictions. To control for a preference for the motion pattern regardless of the role, we implemented a random condition in which we removed the interaction such that two objects were present that moved chaser-like and chasee-like, but noncontingently to each other. Additionally, to control for a preference for the object's position relative to the other (in chasing, the agent is positioned behind and the patient in front), we implemented a condition in which a leader, positioned in front, shows the way to a follower, positioned behind. In this case, the roles were reversed compared with the chasing condition: The agent (the leader) moved in front and the patient (the follower) behind.

# **Research Transparency Statement**

#### **General disclosures**

**Conflicts of interest:** All authors declare no conflicts of interest. **Funding:** This work was supported by Agence Nationale de la Recherche Grant ANR-20-CE28-0005, the Institute for Language, Communication and the Brain through Agence Nationale de la Recherche Grant ANR-16-CONV-0002, and the European Research Counsil (ThoughtOrigins: 101161107). **Artificial intelligence:** No AI was used in writing the manuscript, but AI was sometimes used (ChatGPT) for inspiration while programming the stimuli. No other AI-assisted technologies were used in this research or the creation of this article. **Ethics:** This study received approval from the French Ministère de l'Education Nationale et de la Recherche (Approval No. APAFIS-2717-2015111708173794-V3).

#### Study disclosures

Preregistration: The research aims/hypotheses, method, and analysis plan were preregistered (https:// doi.org/10.17605/OSF.IO/5SZQ4) on May 9, 2023, after data collection had started (which began on April 24, 2023) but prior to data analyses (which began on June 3, 2023). There were minor deviations from the preregistration (for details, see Table S1 in the Supplemental Material available online). Materials: All study materials are publicly available (https://doi.org/10.17605/OSF .IO/AHFMG). Data: All primary data are publicly available (https://doi.org/10.17605/OSF.IO/H63WS). Analy**sis Scripts:** All analysis scripts are publicly available (https://doi.org/10.17605/OSF.IO/W879A). Computational reproducibility: The computational reproducibility of the results has been independently confirmed by the journal's STAR team.

#### Method

#### **Ethics**

The study on baboons was carried out in accordance with French and European Union standards and received approval from the French Ministère de l'Education Nationale et de la Recherche (Approval No. APAFIS-2717-2015111708173794-V3). The procedures used in the current study were also consistent with the guidelines of the Association for the Study of Animal Behavior.

# **Participants**

The study was made available to 23 baboons housed in two groups of 18 and five individuals, respectively, at the Primatology Station in Rousset-sur-Arc, France. Thirteen individuals (10 females; mean age = 12.1 years, SEM = 1.6, range = 5.5–25 years) successfully learned the task and were included in our analyses. The baboons were tested by using 14 automatic learning devices for monkeys (Fagot & Paleressompoulle, 2009) equipped with touch screens and a food dispenser that were freely accessible from their enclosure. The baboons participated voluntarily in these tasks using an operant conditioning method. Data were collected for a period of 40 days from April to June 2023.

# General procedure

We designed a change-detection task. For humans, change-detection paradigms have revealed a substantial role of attention in the detection of changes in scenes (Rensink et al., 1997). Importantly, areas that attract

attention are prone to faster change detection than less attended regions such that, for example, changes to animate entities are noticed faster than changes to inanimate entities (Altman et al., 2016; New et al., 2007, 2010). A similar rationale is used for dot-probe tasks that show faster response times (RTs) for touching the dot behind an attention-attracting picture, and this type of paradigm has been successfully applied to nonhuman primates (van Rooijen et al., 2017).

In our adaptation of the change-detection task, we used a color change that required a touch response. The color change was applied to an object in the animation, as shown in Figure 1. A trial consisted of a fixation cross that had to be touched to start. An animation was then generated in which one object (during training) or two objects (during testing) were moving around on the screen. When one of the objects changed color, the participant had to touch it to earn a food reward. Touching either the background, the object that did not change color, or any object before it changed color resulted in a punishment of a 3-s green time-out screen, after which the trial ended. Without any touching response, the animation stopped after 6 s, and no reward was distributed. The experiment was created in and presented to the baboons with the Open Monkey Mind plug-in of OpenSesame (Mathôt et al., 2012).

# Stimuli and conditions

Stimuli were generated using a Pygame script in OpenSesame. For each trial, a new animation was generated such that no trial was ever the same. The animations were shown with a frame rate of 60 fps on a black  $1,024 \times$ 768 screen. The objects were triangles 70 pixels in size and oriented toward the moving direction. Compared with circular shapes, triangles are known for enhancing the chasing perception (Abdai et al., 2021; Gao et al., 2009). The position of each object on the screen was updated each frame to make it look like it was moving. The stimuli were created with the goal of making the objects in the animation appear animate by mimicking the ability to self-propel and perform speed and directional changes-features to which newborns (Di Giorgio et al., 2017, 2021) and newly hatched chicks (Rosa-Salva et al., 2016) are sensitive.

The moving behaviors were based on Reynold's descriptions of how to program naturally moving autonomous agents, as described by Shiffman (2012). The moving direction was defined by the current velocity vector and the "desired" vector. For each frame, the object was updated from the current to the desired vector (the steering behavior), making the object appear to be moving into the direction of the desired vector.

The desired vector had a combined direction and length based on a combination of different vectors acting on the object. Which forces made up the desired vector depended on the object. Details can be found in our OpenSesame script available on OSF. Several conditions were tested. We present these conditions below.

In the chasing condition, we created a chasing interaction with configurations that are required for the impression of chasing to emerge for humans (Gao et al., 2009; Visch & Tan, 2009). During chasing, one object was the chaser that would always move toward a second object: the chasee. The chasee would be wandering around and would accelerate and flee away when the chaser came close by (a distance of less than 200 pixels). The chaser was thus positioned behind and the chasee in front. In this interaction, the chaser was the agent and the chasee the patient. We tested two versions of chasing, one in which the objects started further away from each other, creating a "heat-seek pursuit" from the chaser, and one in which they started close to one another. A heat-seek pursuit helps human adults and infants detect chasing (Galazka & Nyström, 2016; Gao et al., 2009).

In the following condition, we adjusted the behaviors of chasing such that we removed the fleeing behavior of the object positioned in front, making it seem as if it were leading the way for the object behind. Note that here the agent–patient roles were reversed compared with chasing and now the object positioned in front was the agent and object behind the patient. Again, we implemented two versions of this test, one in which the two objects started far away from one another and one in which they started close by.

In the random condition, two objects were presented that were moving exactly like a chaser and a chasee but not contingently. To achieve this, we generated two sets of chasing interactions, of which one showed only the chaser and the other only the chasee. In the first set, we made the object positioned in front black, leaving only the chaser visible, and in the second, we made the object behind black, leaving only the chasee visible.

Last, we implemented a clone condition that was comparable to the one used by Atsumi and Nagasaka (2015) for squirrel monkeys. Two objects moved side by side, one object moved as a chaser (chasing an invisible chasee), and a second object was placed alongside it. We implemented this condition because we wanted to exclude the possibility that potential differences between the chasing and the random condition could be explained by the fact that in the chasing condition the objects were closer together than they were in the random condition (regardless of the relation), making it easier to parse these stimuli. Baboons are known to have a local processing bias in visual tasks (Deruelle & Fagot, 1998) that may facilitate the processing of objects closer together compared with objects further apart. We thus decided to keep the two objects close to each other and not express an agent–patient relation in the clone condition to test whether this variation would lead to shorter RTs compared with the RTs in the random condition. Example videos of our generated animations can be found on OSF (https:// doi.org/10.17605/OSF.IO/AHFMG).

# Training

We implemented a five-step training phase to familiarize the baboons with our change-detection paradigm. During the training phase, only one object moved across the screen. The participant had to touch the object after it changed color. If the participant touched the object that changed color (within a radius of 140 pixels), this counted as a correct response.

We incrementally increased the timing of the color change and decreased the perceptual saliency of the color change. In Step 1, the color change appeared 100 ms after the onset of the video, in Step 2 it appeared at a randomly chosen time between 500 and 1,000 ms, in Step 3 it appeared between 1,000 and 3,000 ms, and in Steps 4 and 5 it appeared between 3,000 and 4,000 ms. In Steps 1 through 4 we used the color change from blue (RGB 0, 0, 255) to cyan (RGB 0, 255, 255); in Step 5 we used the color change from dark blue (RGB 0, 55, 99) to another dark blue (RGB 37, 43, 99). The two dark blue colors were chosen because they are close but baboons are still able to perceive them as different (Davidoff & Fagot, 2010). At the same time, this color difference is subtle, which requires the baboons' attention to detect it and respond appropriately.

During training, the generated animations were based on the chasing stimuli from the test phase. In half of the trials we showed one object moving chaserlike; in the other half of the trials we showed the object moving chasee-like. We presented these trials in randomized order in blocks of 60 trials, and when a criterion of 80% correct responses was reached, the participant continued to the next step. We measured which participants reached the criteria and in how many blocks they did so (for details, see Table S2 in the Supplemental Material).

# Test phase

During the test phase we showed our participants twoobject animations. We implemented different conditions in the test phase: chasing (both with and without heatseek pursuit), following (with and without heat-seek pursuit), random, and clone. The different conditions were displayed in random order in blocks of 60 trials. We thus had 10 trials per condition per block. The color change was applied at a randomly chosen time between 3,000 and 4,000 ms from dark blue (RGB 0, 55, 99) to another dark blue (RGB 37, 43, 99). The color change was applied to one object in half of the trials and to the other in the remaining trials. Touching the object that changed color (within a radius of 140 pixels) counted as a correct response. We measured RT. We additionally measured accuracy. We collected 80 blocks of 60 trials, leading to 800 trials per condition per participant.

#### Analyses

**Response time.** To measure whether participants would be faster to respond to a color change applied to the agent compared with the patient in a chasing interaction, we tested whether there would be an interaction effect between the RTs to the targets' color change in chasing and in the random condition, in which the objects moved separately and did not display agent and patient roles. We additionally tested whether the direction of the effect between the agent and patient would align for chasing and following to rule out an effect of positioning (in front of or behind the other object).

We analyzed our data using a Bayesian generalized linear mixed model with an ex-Gaussian error structure implemented with the brms R package (Bürkner, 2017). Our preregistered model, RT ~ Condition × Target + (1 + block | participant), turned out to be too complex because it did not converge. To reduce complexity, we decided to focus on the most relevant conditions only chasing, following, and random. We thus excluded the clone condition<sup>1</sup> and merged the chasing with and without heat-seek pursuit as well as the following with and without heat-seek pursuit (because no differences were detected between them; see the Supplemental Material). Our model thus compared a chasing combined condition, a following combined condition, and a random condition.

For all correct trials, we modeled the effect of condition (chasing combined, following combined, and random) interacting with target (which of the two objects present changed color) on the RT after the color change, with intercepts varying per participant. We used the following model: RT ~ Condition × Target + (1 + block |participant). We applied 4,000 iterations and four chains.

For each parameter, we report the estimate (B), estimated error (EE), and 95% credible interval (CI). If zero lied outside the CI, we concluded there was sufficient evidence to suggest the estimate was different from zero.

Additionally, because we expected participants to be faster for the agent compared with the patient in lute difference between the RTs of the two targets per

condition.

Accuracy. Even though participants in the test phase were selected for high accuracy during training (participants needed to reach 80% correct responses to proceed through the five steps of training), we also assessed whether participants would identify a color change applied to the agent in a chasing interaction more accurately than a color change applied to the patient. We thus examined whether there would be an interaction between the accuracies of the two targets in chasing (i.e., agent and patient) and in the random condition, in which the two targets moved noncontingently. We also tested whether the direction of the effect between agent and patient for chasing would align with following because following was designed to control for the positioning of the two objects. We used a Bayesian generalized linear mixed model with a binomial error structure implemented with the brms R package (Bürkner, 2017). We adjusted our preregistered model similarly to the RT model by (a) excluding the clone condition and (b) merging chasing and chasing without heat-seek pursuit into chasing combined and merging following and following without heat-seek pursuit into following combined (see Supplemental Material).

We modeled participants' responses (1 = correct, 0 = incorrect) using a mixed logit model specified as RT ~ Condition × Target + (1 + block | participant), with target being one of the two objects present that changed color. We used 4,000 iterations and four chains.

We also report the *B*, *EE*, and 95% CI for each parameter, consistent with the analyses described above. Likewise, we concluded there was enough evidence for an estimate different from zero if zero lied outside the CI.

We again applied post hoc pairwise comparisons between the accuracies of the two objects within each condition using the computed estimated marginal means of the contrast function of the emmeans R package (Lenth, 2022) to see whether the participants would be more accurate in detecting a color change to the agent than to the patient in chasing.

# Results

#### Training phase

The 13 baboons who successfully passed the training phases averaged 2,806  $\pm$  301 trials. Of the 13 who



**Response Time to Color Change** 

**Fig. 2.** Response times to the color changes applied to the two moving objects in our different conditions. Average response times (in milliseconds) are displayed with a large black dot, and the gray lines indicate individual data.

succeeded training, 10 completed all 4,800 test trials. Three others who completed 2,417 test trials, 2,763 test trials, and 3,568 test trials were included in the analyses. For individual data, see Table S2.

# Test phase

**Response time.** As shown in Figure 2, the RT analysis revealed an interaction between condition and target when comparing the chasing condition with the random condition, B = -37.01, EE = 5.83, 95% CI = [-48.58, -25.65], but not when comparing the chasing condition with the following condition, B = -2.66, EE = 4.65, 95% CI = [-11.72, 6.48]. These results are in line with our hypothesis for an agent bias that is irrespective of motion pattern (random condition) or positioning (following condition).

In the random condition, the baboons were slower to recognize a color change to the chaser-like object than to the chasee-like object (962  $\pm$  22 vs. 932  $\pm$  16 ms), B = 25.82, 95% CI = [16.2, 35.06], suggesting that

the motion of the chasee-like object attracted greater attention than the motion of the chaser-like object. This was the case for nine of the 13 baboons. Importantly, however, when these same objects moved in concert in the chasing condition, the participants were significantly faster to detect the color change to the agent, the chaser, compared with the patient, the chasee (922  $\pm$ 22 vs.  $951 \pm 18$  ms), B = -11.28, 95% CI = [-17.6, -4.75], in line with the hypothesized agent preference. Eleven of the 13 baboons detected a color change to the agent faster than to the patient during chasing. In the following condition, the color change to the agent, the leader, was detected faster than the color change to the patient, the follower (954  $\pm$  30 vs. 966  $\pm$  35 ms), B = -8.51, 95% CI = [-15.0, -2.26], consistent with an agent preference. Nine of the 13 baboons had a faster RT for the agent compared with the patient in the following condition. These results suggest that the agent's position behind the patient in chasing cannot account for faster responses to the color change because in the following condition the



Fig. 3. Accuracy to the color changes applied to the two moving objects in our different conditions. Average accuracy (% correct) scores are displayed with a large black dot, and the gray lines indicate individual data.

agent was positioned in front and yet captured the fastest responses.

**Accuracy.** Accuracy in detecting color changes was consistently high for all conditions and targets because participants were trained to be accurate throughout training and testing by positive reinforcement. As hypothesized, the accuracy analysis showed an interaction between condition and target when comparing the chasing condition with the random condition, B = 0.61, EE = 0.09, 95% CI = [0.43, 0.78], indicating that motion alone cannot explain the accuracy results in chasing (see Fig. 3). Contrary to what we expected, we also found such an interaction when comparing the chasing with the following condition, B = 1.32, EE = 0.08, 95% CI = [1.17, 1.47], showing that the relative positioning of the targets appears to affect accuracy in the following condition.

We tested post hoc for differences in accuracy to detect a color change between the two targets in each condition. In the random condition, the baboons were equally accurate in detecting the color change to the chaser-like object as to the chasee-like object (91.1%  $\pm$ 1.3% vs. 90.7% ± 1.0% correct), B = 0.06, 95% CI = [-0.09, 0.20]. For chasing, the baboons were more accurate for the agent, the chaser, compared with the patient, the chasee  $(92.1\% \pm 1.0\% \text{ vs. } 86.3\% \pm 1.1\%$ correct), B = 0.66, 95% CI = [0.57, 0.77], which is in line with the hypothesized agent preference. In the following condition, the baboons identified the color change to the patient, the follower, more accurately than to the agent, the leader  $(94.2\% \pm 0.8\% \text{ vs. } 89.6\% \pm 0.9\% \text{ cor-}$ rect), B = -0.66, 95% CI = [-0.77, -0.55], which is not in line with an agent preference and shows that the positioning behind the other object (follower behind leader) facilitated responding accurately. We come back to this point in the next section.

#### Discussion

This study demonstrates that Guinea baboons have an agent preference in chasing interactions: They are faster

and more accurate in detecting a color change that is applied to the agent compared with the patient of a chasing interaction. This suggests that baboons exhibit an attentional bias toward the chaser similar to human adults (Meyerhoff et al., 2014) and preverbal infants (Galazka & Nyström, 2016), consistent with our hypothesis.

Importantly, more accurate and faster RTs for the chaser compared with the chasee cannot be attributed to the chaser's specific motion pattern because in the random condition, in which the objects moved independently, baboons were equally accurate for both objects and even exhibited a faster response for the chasee-like object compared with the chaser-like object. We speculate that this facilitating effect for faster responses toward the chasee-like object stemmed from the chasee's more erratic movements. Similar preferences for looking at unpredictable movements have been documented in human adults and dogs (Abdai et al., 2017) and newly hatched chicks (Lemaire et al., 2022). Crucially, when the same two objects moved closer together and in contingency in the chasing condition, this preference for a separately moving chasee shifted in favor of the chaser portraying the agent role. We view this as strong evidence for an agent preference, suggesting that the coordinated motion during chasing overcame the preference for the chasee's motion.

Similarly, faster responses for the chaser compared with the chasee cannot be the result of baboons anticipating the chaser's trajectory on the basis of the motion of the object positioned in front. In the following condition, baboons were faster to respond to the object positioned in front, whose trajectory was not predictable (the agent/leader), compared with the object positioned behind, whose trajectory could be predicted from the first one (the patient/follower). This suggests that motion predictability was not what resulted in faster responses for chasers compared with chasees.

In summary, our findings suggest that baboons possess an agent preference (i.e., a prioritized attention toward agents) when observing events. This agent bias was most visible during chasing events, in which we observed it in RTs and accuracy. In following events, the preference for the agent was smaller in RTs, and the baboons showed a reversed bias (i.e., greater accuracy for the follower) for accuracy. A possible reason for this discrepancy could be that a following interaction is not the most prototypical agent-patient relation in the sense that the agent is facing away from the patient and that an effect of surprise changed the baboon's attentional strategy and response biases in the task. Having an agent facing toward the patient is often considered an important cue for the role attribution (Hafri et al., 2013; Papeo et al., 2024).

Consistent with this idea, five-month-old human infants have been shown to look longer at a chaser in a chasing interaction but not at a leader in a following interaction (Galazka & Nyström, 2016). Baboons' agent preference is thus so far restricted to chasing events. Although data on the agent preference in human adults are based on more varied event types, most infant studies have used chasing patterns (Galazka et al., 2016; Galazka & Nyström, 2016; Yin & Csibra, 2015), making it impossible to judge whether they attend to the chaser because it is the chaser or because it portrays the agent role in an abstract sense (but see Papeo et al., 2024). Further investigation is thus needed to determine whether the agent preference we uncovered for chasing in baboons extends to other events.

The discovery that baboons do not process the chasing events holistically but instead decompose them into agent and patient roles with a specific focus on the agent alludes to the possibility that baboons cognitively represent events in a similar format as humans, akin to a language of thought. The agent preference indeed fulfills a key property of a language of thought: the presence of constituents that are discrete and structured (Quilty-Dunn et al., 2023).

The similarity between baboons' and humans' event processing has important implications. A fundamental cognitive capacity to represent events with a preference for the agent may form the basis of event syntax in languages, consistent with the agency-detection hypothesis proposed by V. A. D. Wilson et al. (2022). This theory accounts for the tight link between event cognition and linguistic structure (Papafragou & Grigoroglou, 2019; Rissman & Majid, 2019; Ünal & Papafragou, 2016) and maintains that cross-linguistic syntactic regularities in linguistic event descriptions are externalizations of how we mentally represent them (Strickland, 2017; Ünal et al., 2021; Zuberbühler & Bickel, 2022). At a minimum, our results suggest that the cognitive mechanisms involved in processing events are evolutionarily old and can possibly be traced back to at least the last common ancestor between baboons and humans who lived approximately 30 million years ago.

Considering the relatively recent emergence of language in humans, we propose that it draws on various cognitive functions that have evolved for diverse purposes. The ability to represent "who is doing what to whom" may be a fundamental cognitive capacity shared across species. An agent preference serves as a possible explanation for why we observe a cross-linguistic tendency to emphasize the subject by placing it first. This word order may stem from an agent preference rooted in cognition, challenging the idea that wordorder patterns are solely the product of deep linguistic principles.

# Transparency

Action Editor: Tom Beckers Editor: Simine Vazire Author Contributions

**Floor Meewis:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Visualization; Writing – original draft; Writing – review & editing.

**Joël Fagot:** Conceptualization; Resources; Writing – review & editing.

**Nicolas Claidière:** Conceptualization; Investigation; Methodology; Project administration; Resources; Supervision; Writing – review & editing.

**Isabelle Dautriche:** Conceptualization; Formal analysis; Funding acquisition; Methodology; Project administration; Resources; Supervision; Writing – original draft; Writing – review & editing.

#### Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

#### Funding

This work was supported by Agence Nationale de la Recherche Grant ANR-20-CE28-0005, the Institute for Language, Communication and the Brain through Agence Nationale de la Recherche Grant ANR-16-CONV-0002, and the European Research Council (ThoughtOrigins: 101161107).

Artificial Intelligence

No AI was used in writing the manuscript, but AI was sometimes used (ChatGPT) for inspiration while programming the stimuli. No other AI-assisted technologies were used in this research or the creation of this article.

Ethics

This study received approval from the French Ministère de l'Education Nationale et de la Recherche (Approval No. APAFIS-2717-2015111708173794-V3).

#### **Open Practices**

Preregistration: The research aims/hypotheses, method, and analysis plan were preregistered (https://doi.org/10.17605/ OSF.IO/5SZQ4) on May 9, 2023, after data collection had started (which began on April 24, 2023) but prior to data analyses (which began on June 3, 2023). There were minor deviations from the preregistration (for details, see Table S1 in the Supplemental Material available online). Materials: All study materials are publicly available (https://doi.org/ 10.17605/OSF.IO/AHFMG). Data: All primary data are publicly available (https://doi.org/10.17605/OSF.IO/H63WS). Analysis Scripts: All analysis scripts are publicly available (https://doi.org/10.17605/OSF.IO/W879A). Computational reproducibility: The computational reproducibility of the results has been independently confirmed by the journal's STAR team.

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# Acknowledgments

We thank Julie Gullstrand, Sebastien Barniaud, and the staff at the Primatology Station for their help with the experiments with the baboons.

# **Supplemental Material**

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/09567976251344581

#### Note

1. The clone condition was implemented to verify whether it would be easier to parse an animation with two objects moving close together (such as in the chasing and following conditions) compared with two objects moving far apart (such as in the random condition), but this was not the case. We observed an average response time of  $1,024 \pm 32$  ms in the clone condition, which appears to be higher than the response times in the random condition:  $947 \pm 14$  ms averaged over the two objects. This indicates that the clone condition with two objects close together was not easier but in fact harder to parse than the other conditions.

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