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- 1 Agent preference in chasing interactions in Guinea baboons (*Papio papio*):
- 2 uncovering the roots of subject-object order in language

3 **Abstract**

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

13

14 **Keywords:** agent-patient, thematic roles, event cognition, language evolution, linguistic universal, syntax

15 **Research Transparency Statement**

16 **General Disclosures**

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24 2015111708173794-V3). Computational reproducibility: The computational reproducibility of the results
25 has been independently confirmed by the journal's STAR team.

26

27 **Study One Disclosures**

28 Preregistration: The research aims/hypotheses, methods, and analysis plan were preregistered
29 (<https://doi.org/10.17605/OSF.IO/5SZQ4>) on 2023-05-09 after data collection had started (which began
30 on 2023-04-24), but prior to data analyses (which began on 2023-06-03). There were minor deviations
31 from the preregistration (for details see Supplementary Table 1).
32 Materials: All study materials are publicly available (<https://doi.org/10.17605/OSF.IO/AHFMG>).
33 Data: All primary data are publicly available (<https://doi.org/10.17605/OSF.IO/H63WS>).
34 Data: All analysis scripts are publicly available (<https://doi.org/10.17605/OSF.IO/W879A>).

35

36 Introduction

37 Human languages vary greatly at all levels of description, yet they also share an important number of
38 commonalities (Greenberg, 1963). For instance, in 97% of languages with a dominant word order, the
39 subject (S) precedes the object (O) (Dryer, 2013), e.g., "the girl (S) pushed the boy (O)" in English or "larki-
40 ne (S) larke-ko (O) dhakka diya" in Hindi. These cross-linguistic statistical regularities have been the topic
41 of many enquiries in the cognitive science of language, but their origin remains a topic of ongoing debates
42 (Chomsky, 1957; Culbertson et al., 2020; Evans & Levinson, 2009; MacWhinney, 1977). Statistical
43 universals may be the product of language contact and history (Dunn et al., 2011) and/or reflect
44 evolutionary processes that are independent of cognition (Bybee, 2006, 2009; Gibson et al., 2019; Kirby
45 et al., 2008). Another possibility is that they are the result of cognitive biases and mental representations
46 that pre-exist language (Culbertson & Kirby, 2016; Martin et al., 2024; Strickland, 2017). For instance, the
47 tendency for word orders to prioritize subjects before objects may originate from the way humans
48 naturally process events around them, with a preference for attending to agents (typically mapped to
49 subject positions) before patients (typically mapped to object positions) (Jackendoff, 1999; Ünal et al.,
50 2021). Such an agent preference, i.e., a prioritized attention towards agents when observing events, has
51 been recently argued to have deep evolutionary roots beyond human language (Wilson et al., 2022;
52 Zuberbühler, 2019, 2020, 2022; Zuberbühler & Bickel, 2022).

53 The strong link between linguistic event descriptions and event cognition provides support for this
54 theory (Rissman & Majid, 2019; Ünal et al., 2021). While reflected as specific arguments in active transitive
55 sentences, the underlying conceptual structure is thought to be more general: the agent (doer) causes an
56 action that affects the patient (undergoer; Fillmore, 1968; Jackendoff, 2002). Furthermore, the agent and
57 patient are often characterized by features that are associated with their role, such as the agent's volitional
58 behaviour, awareness, motility and independence, while the patient is defined by its reliance on the agent,
59 undergoing change, and being less dynamic (Dowty, 1991). It follows that attributes such as agency
60 (intentionality and goal-directedness) and animacy (being alive) are applicable to both roles, but are more
61 likely to be associated with the agent role. Even though speakers can use linguistic devices to highlight any
62 argument by placing it first, e.g., the patient in passive structures, placing the agent in subject position
63 appears to be the default (Bickel et al., 2015; Gertner & Fisher, 2012).

64 Evidence that agent and patient may be represented in an abstract sense, comes from experiments
65 demonstrating the saliency of these roles, and in particular the agent, over a wide range of events, such
66 as pictures, drawings and even animations with 2D-shapes. Not only do human adults spontaneously and
67 unconsciously extract event roles from brief visual events (Hafri et al., 2013, 2018), but agents attract their

68 attention more than patients. While watching events, human adults first direct their gaze toward the agent
69 of an action (Webb et al., 2010). Similarly, in cartoons, agents are looked at longer than patients (Cohn &
70 Paczynski, 2013) and from short displays of drawings, agents are systematically better identified compared
71 to patients, instruments and actions (Dobel et al., 2007). Furthermore, adults are faster to orient to agents
72 when asked to detect agents than to orient to patients when asked to detect patients (Wilson et al., 2011).

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

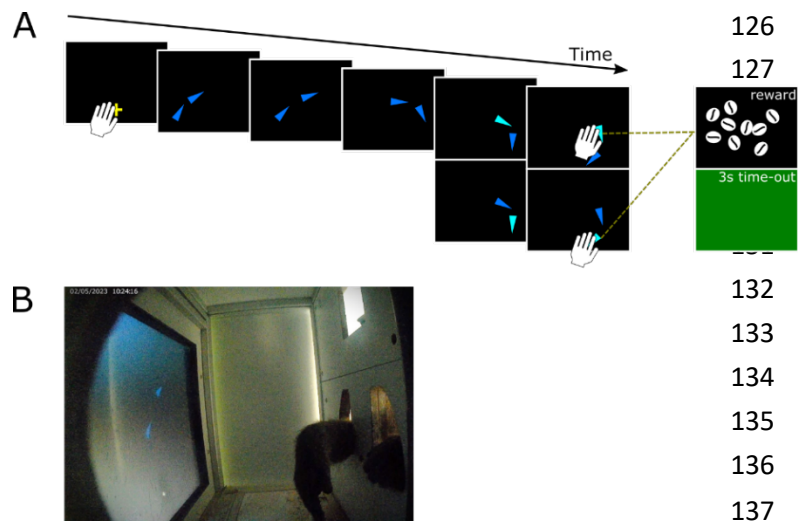
82 Although an agent preference is thus found under non-linguistic conditions, its evolutionary origins
83 remain a mystery. One possibility is that an agent preference can be found in non-human animals. This
84 would suggest that the structure of event representations has an old evolutionary history and may form
85 the roots of one of the key characteristics of human language, its subject-object word order. Alternatively,
86 an agent preference could be a typically human bias that has evolved concurrently with language (Wilson
87 et al., 2022). The evidence for an agent preference in non-human animals so far is not conclusive. Although
88 non-human animals can detect some cues indicative of animacy (Hauser, 1998; Rosa-Salva et al., 2016),
89 less is known about using the relational aspect of an interaction to identify agents as compared to patients.
90 Great apes (chimpanzees (*Pan troglodytes*), gorillas (*Gorilla gorilla*) and orangutans (*Pongo abelii*)) scan
91 videos of dyadic event scenes similarly to humans with their gaze alternating between the agent and the
92 patient, but in this study an agent preference was not observed in any of the species (including humans)
93 (Wilson et al., 2023). At present, it thus remains unclear whether non-human animals also show an
94 attentional bias for agents as compared to patients.

95 Here, we investigated the evolutionary origin of the agent preference in Guinea baboons (*Papio papio*).
96 Baboons share a common ancestor with humans that lived 25-30 Mya. They have evolved under similar
97 environmental conditions as humans (Fischer et al., 2019), making them a good model species for
98 language evolution (Fagot et al., 2019), especially with regards to possible roots in social cognition
99 (Seyfarth & Cheney, 2014). To test an agent preference in Guinea baboons, we studied their response to

100 generated animations of chasing interactions in which the agent and the patient were represented by two
101 identical, simple geometrical shapes. Although it is debated whether monkeys attribute mental states to
102 2D shapes (Schafroth et al., 2021), forms similar to ours have been repeatedly used in previous studies,
103 which revealed that chasing can be discriminated from other motion patterns by human adults (Abdai et
104 al., 2017; Atsumi et al., 2017; Barrett et al., 2005; Hofrichter & Rutherford, 2019; Meyerhoff et al., 2014;
105 Rochat et al., 1997), human infants (Frankenhuis et al., 2013; Rochat et al., 1997) and several non-human
106 species, including dogs (*Canis familiaris*; Abdai et al., 2017; Abdai & Miklósi, 2022), cats (*Felis silvestris*
107 *catus*; Abdai & Miklósi, 2022), rhesus macaques (*Macaca mulatta*, Atsumi et al., 2017), squirrel monkeys
108 (*Saimiri sciureus*; Atsumi & Nagasaka, 2015) and pigeons (*Columba livia*; Goto et al., 2002).

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

125



138 *Fig. 1. Experimental set-up. Panel A shows an experimental trial of the chasing change detection task. First, a fixation*
139 *cross appears that has to be touched by the participant. Next, an animation with moving objects is generated.*
140 *Depicted here are two objects involved in a chasing interaction. After a certain period, one of the objects will change*
141 *color. On the top row the agent changed color, on the bottom row the patient changed color. The changed object*
142 *requires a touch response which subsequently results in a food reward as shown by the dotted line (top). Any other*
143 *touches result in a three-second time-out screen (bottom). Panel B shows a participant taking part in the experiment.*

144 Method

145 **Ethics statement**

146 The study on baboons was carried out in accordance with French and EU standards and received
147 approval from the French Ministère de l'Éducation Nationale et de la Recherche (approval #APAFIS-2717-
148 2015111708173794-V3). Procedures used in the present study were also consistent with the guidelines of
149 the Association for the Study of Animal Behavior.

150

151 **Participants**

152 The study was made available to a group of 23 baboons who are housed at the “Station de
153 Primatologie” in Rousset-sur-Arc (France) in two groups of eighteen and five individuals. 13 individuals (10
154 females, mean age = 12.1 ± 1.6 (SEM) years, age range = 5.5-25.1 years) successfully learnt the task and
155 were included in our analyses. The baboons were tested by using 14 automatic learning devices for
156 monkeys (ALDM; Fagot & Paleressompoulle, 2009), equipped with touch screens and a food dispenser,
157 which were freely accessible from their enclosure. The baboons participated voluntarily in these tasks
158 employing an operant conditioning method.

159 Data collection started at the end of April 2023 and finished in the beginning of June 2023 for a period
160 of forty days.

161

162 **General procedure**

163 We designed a change detection task. For humans, change detection paradigms have revealed a
164 substantial role of attention in the detection of changes in scenes (Rensink et al., 1997). Importantly, areas
165 that attract attention are prone to faster change detection than less-attended regions, such that, for
166 example, changes to animate entities are noticed faster than to inanimate entities (Altman et al., 2016;
167 New et al., 2007, 2010). A similar rationale is used for dot-probe tasks which show faster response times
168 for touching the dot behind an attention-attracting picture and this type of paradigm has been successfully
169 applied to non-human primates (van Rooijen et al., 2017).

170 In our adaptation of the change detection task, we used a color change which required a touch
171 response. The color change was applied to an object in the shown animation, see Fig. 1. A trial consisted
172 of a fixation cross, which had to be touched to start. Next, an animation was generated in which one object
173 (during training) or two objects (during testing) were moving around on the screen. When one of them
174 changed color, the participant had to touch it to earn a food reward. Touching either the background, the
175 object that did not change color or any object before it changed color, resulted in a punishment of a three

176 second green time-out screen, after which the trial ended. Without any touching response, the animation
177 stopped after six seconds, and no reward was distributed. The experiment was created in and presented
178 to the baboons with the Open Monkey Mind plugin of OpenSesame (Mathôt et al., 2012).

179

180 **Stimuli and conditions**

181 The stimuli were generated using a Pygame script in OpenSesame. For each trial, a new animation was
182 generated such that no trial was ever the same. The animations were shown with a framerate of 60 fps on
183 a black 1024 x 768 screen. The objects were triangles of 70 pixels in size, oriented towards the moving
184 direction. Compared to circular shapes, triangles are known for enhancing the chasing perception (Abdai
185 et al., 2021; Gao et al., 2009). The position of each object on the screen was updated each frame to make
186 it look like it was moving. The stimuli were created with the goal of making the objects in the animation
187 appear animate by mimicking the ability to self-propel and perform speed and directional changes;
188 features to which newborns (Di Giorgio et al., 2017, 2021) and newly-hatched chicks (Rosa-Salva et al.,
189 2016) are sensitive.

190 The moving behaviors were based on Reynold’s descriptions of how to program naturally moving
191 autonomous agents as described by Shiffman (Shiffman, 2012). The moving direction was defined by the
192 current velocity vector and the ‘desired’ vector. Each frame, the object was updated from the current to
193 the desired vector (the steering behavior), making the object appear to be moving into the direction of
194 the desired vector. The desired vector had a combined direction and length based on a combination of
195 different vectors that are acting on the object. Which forces made up the desired vector depended on the
196 object. Details can be found in our Open Sesame script, which is available on [OSF](#).

197 Several testing conditions will be presented below. For the chasing condition, we created a chasing
198 interaction with configurations that are required for the impression of chasing to emerge for humans (Gao
199 et al., 2009; Visch & Tan, 2009). During chasing, one object was the chaser that would always move
200 towards a second object, the chasee. The chasee was wandering around and would accelerate and flee
201 away when the chaser came close by (distance smaller than 200 pixels). The chaser is thus positioned
202 behind and the chasee in front. In this interaction, the chaser is the agent and the chasee is the patient.
203 We had two versions of chasing, one where the objects started further away from each other, creating a
204 “heat-seek pursuit” from the chaser, and one where they would start close to one another. A heat-seek
205 pursuit helps human adults and infants detect chasing (Galazka & Nyström, 2016; Gao et al., 2009).

206 For the following condition, we adjusted the behaviors of chasing such that we removed the fleeing
207 behavior of the object positioned in front, making it seem as if it was leading the way for the object behind.

208 Note that here the agent-patient roles are reversed compared to chasing and now the object positioned
209 in front is the agent and object behind the patient. Again, we implemented two versions of following, one
210 where the two objects started far away from one another and one where they started close by.

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

216 Additionally, we had a final condition called clone. The clone condition was comparable to the one used
217 by Atsumi & Nagasaka for squirrel monkeys (Atsumi & Nagasaka, 2015). Two objects moved side-by-side,
218 one object moved as a chaser (chasing an invisible chasee) and a second object was placed alongside it.
219 We implemented this condition because we wanted to exclude the possibility that potential differences
220 between the chasing and the random condition could be explained by the fact that in chasing the objects
221 were closer together than in random (regardless of the relation) making it easier to parse these stimuli.
222 Baboons are known to have a local processing bias in visual tasks (Deruelle & Fagot, 1998), which may
223 facilitate the processing of objects closer together compared to objects further apart. In the clone
224 condition, we thus decided to keep the two objects close to each other, but not expressing an agent-
225 patient relation, to test whether this would lead to shorter response times compared to random.

226 Example videos of our generated animations can be found on OSF
227 (<https://doi.org/10.17605/OSF.IO/AHFMG>).

228

229 **Training**

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

234 We incrementally increased the timing of the color change and we decreased the perceptual saliency
235 of the color change. In step 1, the color change appeared 100ms after the onset of the video, in step 2 it
236 appeared at a randomly chosen time between 500 and 1000ms, in step 3 it was between 1000 and 3000ms
237 and in step 4 and 5 between 3000 and 4000ms. In steps 1-4 we used the color change from blue
238 (RGB(0,0,255)) to cyan (RGB(0,255,255)), in step 5 we used dark blue (RGB(0,55,99)) to another dark blue
239 (RGB(37,43,99)). The two dark blue colors were chosen because they are close, but baboons are still able

240 to perceive them as different (Davidoff & Fagot, 2010). At the same time, this color difference is subtle,
241 which requires the baboons' attention to detect it and respond appropriately.

242 During training, the generated animations were based on the chasing stimuli from the test phase. Half
243 of the trials, we showed one object moving chaser-like and half of the trials, chasee-like. We presented
244 these trials in randomized order in blocks of 60 trials and when a criterion of 80% correct responses was
245 reached, the participant continued to the next step. We measured which participants reached the criteria
246 and in how many blocks they did so (see SI).

247

248 **Test phase**

249 During the test phase we showed our participants two-object animations. We implemented different
250 conditions in the test phase: chasing (both with and without heat-seek pursuit), following (with and
251 without heat-seek pursuit), random and clone.

252 The different conditions were displayed in random order in blocks of 60 trials. We thus had 10 trials per
253 condition per block. The color change was applied at a randomly chosen time between 3000 and 4000ms
254 from dark blue (RGB(0,55,99)) to another dark blue (RGB(37,43,99)). The color change was applied to one
255 object in half of the trials and to the other in the remaining trials. Touching the object that changed color
256 (within a radius of 140 pixels) counted as a correct response. We measured response time. We additionally
257 measured accuracy, see SI for details. We collected 80 blocks of 60 trials, leading to 800 trials per condition
258 per participant.

259

260 **Analyses**

261 **Response time**

262 To measure whether participants would be faster to respond to a color change applied to the agent
263 compared to the patient in a chasing interaction, we tested whether there would be an interaction effect
264 between the response times to the targets' color change in chasing and in the random condition, in which
265 the objects are moving separately and do not display agent and patient roles. We additionally tested
266 whether the direction of effect between the agent and patient would align for chasing and following to
267 rule out an effect of positioning (in front or behind the other object).

268 We analyzed our data using a Bayesian generalized linear mixed model with ex-gaussian error structure
269 implemented with the brms R package (Bürkner, 2017). Our preregistered model ($RT \sim \text{condition} * \text{target}$
270 $+ (1+\text{block}|\text{participant})$) turned out to be too complex, as it did not converge. To reduce complexity, we
271 decided to 1) focus on the most relevant conditions only: chasing, following and random, excluding the

272 clone condition¹ and 2) merge the chasing with and without heat-seek pursuit, as well as the following
273 with and without heat-seek pursuit (as we detected no differences between them, see SI). Our model thus
274 compares a chasing combined condition, a following combined condition and a random condition.

275 For all correct trials, we modelled the effect of condition (chasing combined, following combined and
276 random) interacting with target (which of the two objects present changed color) on the response time
277 after the color change, with intercepts varying per participant. We used the following model: $RT \sim$
278 $condition * target + (1+block|participant)$. We applied 4000 iterations and 4 chains.

279 For each parameter, we report estimates (B), estimated error (EE), and the 95% credible interval (CI). If
280 zero lies outside the credible interval, we conclude there is sufficient evidence to suggest the estimate is
281 different from zero.

282 Additionally, since we expected participants to be faster for the agent compared to the patient in
283 chasing, we conducted post-hoc pairwise comparisons between the response times of the two objects
284 within each condition. We used the computed estimated marginal means from the function 'contrast' of
285 the R package 'emmeans' (Lenth, 2022) to determine whether there was an absolute difference between
286 the response times of the two targets per condition.

287

288 **Accuracy**

289 Even though participants in the test phase were selected for high accuracy during training (participants
290 needed to reach 80% correct responses to proceed through the five steps of training), we also assessed
291 whether participants would identify a color change applied to the agent in a chasing interaction more
292 accurately than a color change applied to the patient. We thus examined whether there would be an
293 interaction between the accuracies of the two targets in chasing (i.e., agent and patient) and in the random
294 condition, where the two targets moved non-contingently. We also tested whether the direction of effect
295 between agent and patient for chasing would align with following, since following was designed to control
296 for the positioning of the two objects. We used a Bayesian generalized linear mixed model with binomial
297 error structure implemented with the brms R package (Bürkner, 2017). We adjusted our preregistered
298 model similarly to the response time model, by 1) excluding the clone condition and 2) merging chasing

¹ The clone condition was implemented to verify whether it may be easier to parse an animation with two objects that move close together (like chasing and following) compared to far apart (like random), but this was not the case. We observed an average response time of $1024 \pm 32(\text{SEM})$ ms in the clone condition, which appears to be higher than the response times in the random condition: $947 \pm 14(\text{SEM})$ ms averaged over the two objects, indicating that the clone condition with two objects close together was not easier, but in fact harder, to parse than the other conditions.

299 and chasing without heat-seeK pursuit into chasing combined and merging following and following without
300 heat-seeK pursuit into following combined (see below).

301 We modelled participants' responses (1 for correct, 0 for incorrect) using a mixed logit model specified
302 as: $\text{response} \sim \text{condition} * \text{target} + (1 + \text{block} | \text{participant})$ with target being one of the two objects present
303 that changed color. We used 4000 iterations and 4 chains.

304 Like for the response time analyses, we report estimates (B), estimated error (EE), and the 95% credible
305 interval (CI) and conclude there is enough evidence for an estimate different from zero if zero lies outside
306 the credible interval.

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

311

312

313 Results

314 Training phase

315 The 13 baboons who successfully passed the training phases took on average 2806 ± 301 trials. Of the
316 13 who succeeded training, 10 completed all 4800 test trials. Three others who completed 2417 test trials,
317 2763 test trials and 3568 test trials were included in the analyses. See SI Table 2 for individual data.

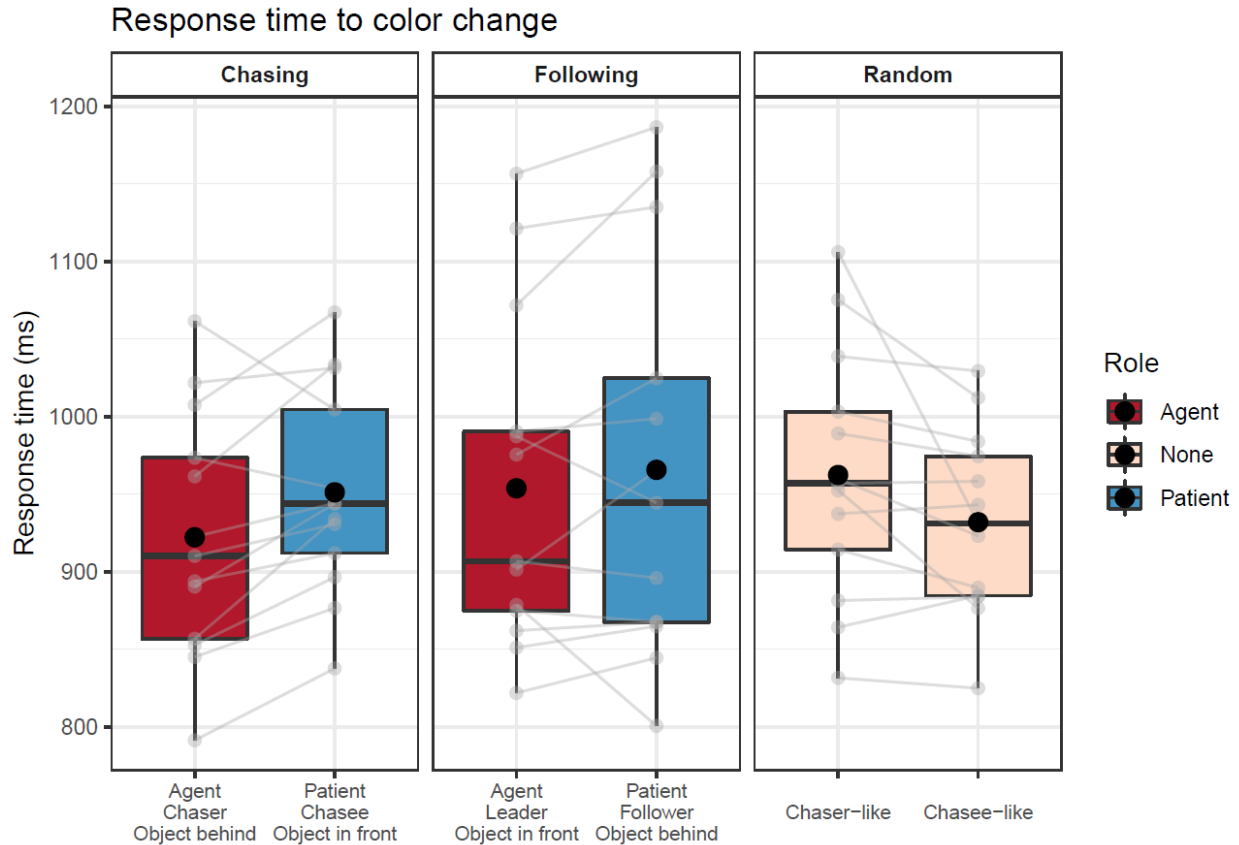
318

319 Test phase

320 Response time

321 Our response time analysis revealed an interaction between condition and target when comparing the
322 chasing condition to the random condition ($B = -37.01$, $EE = 5.83$, $95\% \text{ CI} = [-48.58, -25.65]$), but not when
323 comparing the chasing condition to the following condition ($B = -2.66$, $EE = 4.65$, $95\% \text{ CI} = [-11.72, 6.48]$),
324 see Fig. 2. These results are in line with our hypothesis for an agent bias that is irrespective of motion
325 pattern (random condition) or positioning (following condition).

326 In the random condition, the baboons were slower to recognize a color change to the chaser-like object
327 than to the chasee-like object ($962 \pm 22(\text{SEM})$ ms vs. $932 \pm 16(\text{SEM})$ ms, $B = 25.82$, $95\% \text{ CI} = [16.2, 35.06]$),
328 suggesting that the motion of the chasee-like object attracts greater attention than the motion of the
329 chaser-like object. This was the case for 9 of 13 baboons. Importantly however, when these same objects
330 moved in concert in the chasing condition, the participants were significantly faster to detect the color
331 change to the agent, the chaser, compared to the patient, the chasee ($922 \pm 22(\text{SEM})$ ms vs. $951 \pm$
332 $18.4(\text{SEM})$ ms, $B = -11.28$; $95\% \text{ CI} = [-17.6, -4.75]$), in line with the hypothesized agent preference. 11 of
333 13 baboons detected a color change faster for the agent than the patient during chasing. In the following
334 condition, the color change to the agent, the leader, was detected faster than to the patient, the follower
335 ($954 \pm 30(\text{SEM})$ ms vs. $966 \pm 35(\text{SEM})$ ms, $B = -8.51$; $95\% \text{ CI} = [-15.0, -2.26]$), consistent with an agent
336 preference. 9 of 13 baboons had a faster response time for the agent compared to the patient in following.
337 These results suggest that the agent's position behind the patient in chasing cannot account for faster
338 responses when a color change is applied to the agent compared to the patient in a chasing interaction,
339 because in the following condition, the agent was positioned in front and yet captured the fastest
340 responses.



341

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

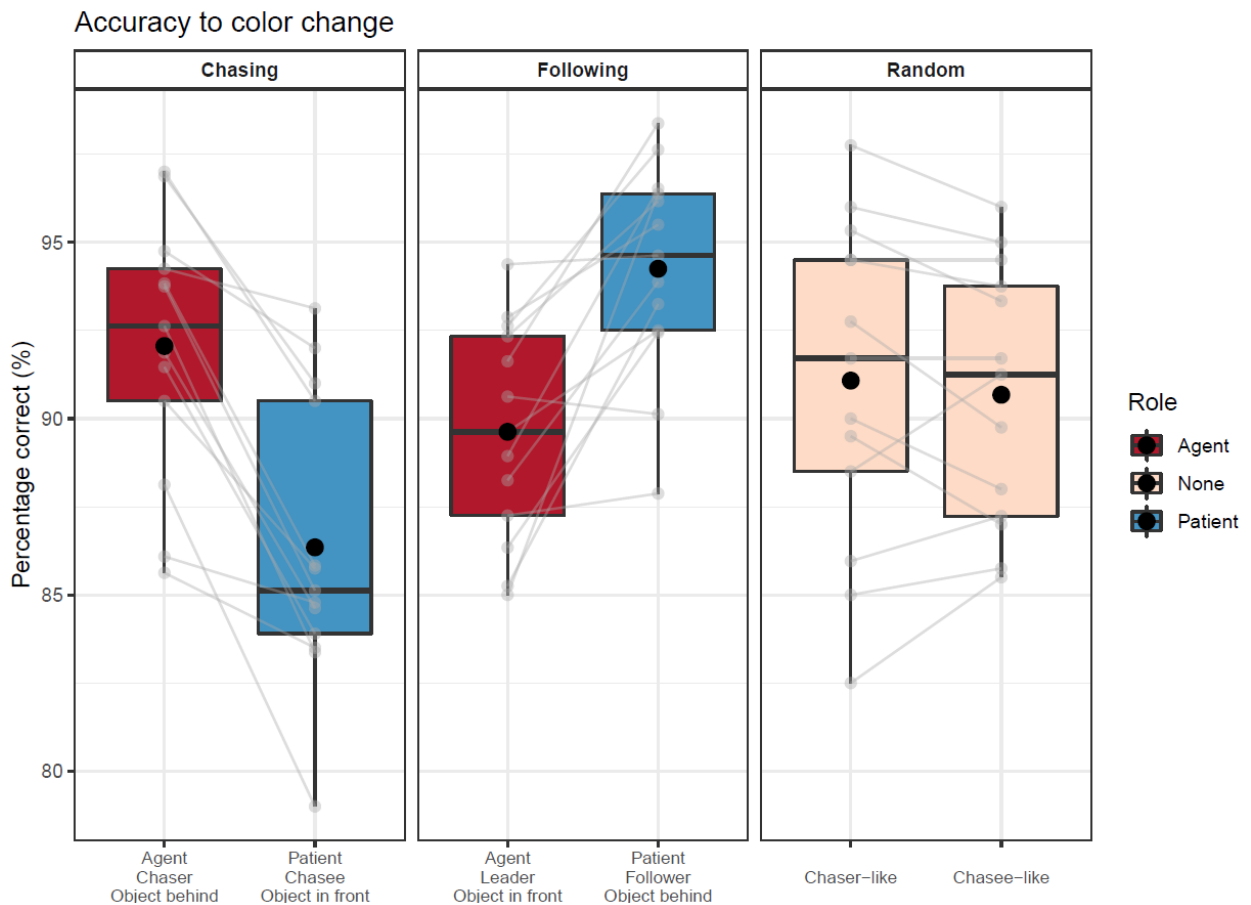
344

345 **Accuracy**

346 Accuracy in detecting color changes was consistently high for all conditions and targets because
 347 participants were trained to be accurate throughout training and testing by positive reinforcement. As
 348 hypothesized, the accuracy analysis showed an interaction between condition and target when comparing
 349 the chasing condition and the random condition ($B = 0.61$, $EE = 0.09$, $95\% \text{ CI} = [0.43, 0.78]$), indicating that
 350 motion alone cannot explain the results in chasing, see Fig. 3. Contrary to our expectations, we also found
 351 such an interaction when comparing the chasing and the following condition ($B = 1.32$, $EE = 0.08$, $95\% \text{ CI}$
 352 $= [1.17, 1.47]$), showing that the relative positioning appears to affect accuracy in the following condition.

353 Post-hoc, we tested for differences in accuracy to detect a color change between the two targets in
 354 each condition. In the random condition, the baboons were equally accurate to detect the color change
 355 to the chaser-like object as to the chasee-like object ($91.1 \pm 1.3(\text{SEM})\%$ correct vs. $90.7 \pm 1.0(\text{SEM})\%$
 356 correct, $B = 0.06$, $95\% \text{ CI} = [-0.09, 0.20]$). For chasing, the baboons were more accurate for the agent, the
 357 chaser, compared to the patient, the chasee ($92.1 \pm 1.0(\text{SEM})\%$ correct vs. $86.3 \pm 1.1(\text{SEM})\%$ correct, $B =$

358 0.66, 95% CI = [0.57, 0.77]), which is in line with the hypothesized agent preference. In the following
 359 condition, the baboons identified the color change to the patient, the follower, more accurately than to
 360 the agent, the leader (94.2 ± 0.8(SEM) % correct vs. 89.6 ± 0.9(SEM) % correct, B = -0.66, 95% CI = [-0.77,
 361 -0.55]), which is not in line with an agent preference and shows that the positioning behind the other
 362 object (follower behind leader) facilitates responding accurately. We come back to this point in the
 363 discussion.
 364



365
 366 *Fig. 3. Accuracy (in % correct) to the color changes applied to the two moving objects in our different conditions.*
 367 *Average accuracy scores are displayed with a large black dot and the grey lines indicate individual data.*

368 Discussion

369 This study demonstrates that Guinea baboons have an agent preference in chasing interactions: they
370 are faster and more accurate to detect a color change that is applied to the agent compared to the patient
371 of a chasing interaction. This suggests that, consistent with our hypothesis, baboons exhibit an attentional
372 bias towards the chaser similarly to human adults (Meyerhoff et al., 2014) and preverbal infants (Galazka
373 & Nyström, 2016).

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

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

391 In summary, our findings suggest that baboons possess an agent preference, i.e., a prioritized attention
392 towards agents when observing events. This agent bias was most visible during chasing events, where we
393 observed it in response time and accuracy. In following events, the preference for the agent was smaller
394 in response time and the baboons showed a reversed bias (i.e., greater accuracy for the follower) for
395 accuracy. A possible reason for this discrepancy could be that a following interaction is not the most
396 prototypical agent-patient relation in the sense that the agent is facing *away* from the patient, and that
397 an effect of surprise changed the baboon's attentional strategy and response biases in the task. Often,
398 having an agent facing towards the patient is considered an important cue for the role attribution (Hafri
399 et al., 2013; Papeo et al., 2024). Consistent with this idea, five-months-old human infants looked longer to

400 a chaser in a chasing interaction but not to a leader in a following interaction (Galazka & Nyström, 2016).
401 Baboons' agent preference is thus so far restricted to chasing events. Although data on the agent
402 preference in human adults is based on more varied event types, most infant studies used chasing patterns
403 (Galazka et al., 2016, 2016; Yin & Csibra, 2015) making it impossible to judge whether they attend to the
404 chaser because it is the chaser or because it portrays the agent role in an abstract sense (but see: Papeo
405 et al., 2024). Further investigation is thus needed to determine whether the agent preference we
406 uncovered for chasing in baboons, extends to other events.

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

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

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

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