Behavioural Processes 170 (2020) 103993

Contents lists available at ScienceDirect

Behavioural Processes

journal homepage: www.elsevier.com/locate/behavproc

Short report

Object preferences in captive Sumatran orang-utans (*Pongo abelii*)

Sonja J. Ebel[a,b,c,*], Kathrin S. Kopp[a,b,c], Katja Liebal[a]

[a] Department of Comparative Developmental Psychology, Freie Universität Berlin, Berlin, Germany
[b] Department of Comparative Cultural Psychology, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany
[c] Department of Primatology, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

ARTICLE INFO

Keywords:
Colour preference
Object exploration
Primates
Sex differences
Shape preference

ABSTRACT

While preferences for perceptual features of objects are well studied in humans, little is known about this trait in other great apes. We therefore presented captive Sumatran orang-utans (*Pongo abelii*) with objects that differed in shape (spherical, cuboid), colour (red, green), or texture (hard, soft). Overall, orang-utans preferred spherical over cuboid and red over green objects. Soft objects were preferred over hard ones. However, this preference might be confounded by the decomposable characteristic of soft objects since the orang-utans often unwrapped them. This study shows object preferences in orang-utans similar to those in humans, suggesting that perceptual preferences for basic object features such as shape and colour may be shared across primate species.

1. Introduction

Non-human primates are surrounded by and encounter a variety of objects (other than food). In their natural habitat, these might be, for example, stones or pieces of wood, whereas captive primates also face a variety of human artefacts, such as jute bags or plastic cans. In humans, object preferences influence attention towards and actions with objects and it is likely that they also do so in other species (Neiworth et al., 2007; Sireteanu et al., 2005; Spering et al., 2008). Some object preferences reflect evolutionary adaptations, e.g. certain colours indicate edibility of objects (Lucas et al., 2003; Crozier, 1997). Therefore, studying non-human primates may reveal if such preferences are shared with our closest relatives.

Already young children exhibit preferences for basic object features. Regarding shape, 1-to-2-year-olds prefer roundish over angular shapes (Jadva et al., 2010). Some authors consider sharp transitions in contours to represent threatening stimuli resulting in an avoidance of sharp angled contours (Bar and Neta, 2006). Regarding colour, children younger than one year preferentially look at red compared to green (Franklin et al., 2008, 2010). This colour preference may have evolved with trichromatic colour vision in catarrhine primates to detect red fruits and leaves in front of green foliage (Dominy and Lucas, 2001). Regarding texture, 3-to-12-month-old children favour hard objects over soft ones, with this preference becoming stronger with age and being more pronounced in boys than in girls (Furby and Wilke, 1982). This preference may reflect different types of stimulation and action patterns sought and carried out by children at different ages (Furby and Wilke, 1982).

Few studies have investigated object preferences in primates yet. However, an eye-tracking study on shape preferences in chimpanzees and gorillas showed that they preferentially looked at roundish over angular shapes (Munar et al., 2015). In relation to colour, results on primates' preferences are inconsistent across studies: While chimpanzees and gorillas preferred blue and green objects over red ones (Wells et al., 2008), no colour preferences were found in orang-utans (Mühlenbeck et al., 2015; Barbiers, 1985). Rhesus monkeys preferred blue over red light (Sahgal et al., 1975), but females looked longer at reddish coloured infant faces than at greenish ones (Higley et al., 1987). Regarding texture, infant chimpanzees preferred soft cubes over wooden ones at first, but the preference disappeared across time (Takeshita et al., 2005).

Some studies compared preferences for human toys in males and females: Vervet monkeys preferentially played with human sex-stereotyped toys (males: car/ball, females: doll/pot; Alexander and Hines, 2002), and male rhesus monkeys preferred wheeled toys over plush toys, whereas females did not exhibit a preference (Hassett et al., 2008). However, it remains unclear which object features these preferences were based on (but see Williams and Pleil, 2008).

Therefore, we investigated whether captive orang-utans preferentially manipulated objects because of their shape (spherical, cuboid), colour (red, green), or texture (hard, soft). We investigated their preference for touching an object (contact time) and actively engaging

* Corresponding author at: Department of Comparative Cultural Psychology, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, 04103 Leipzig, Germany.
E-mail address: sonja_ebel@eva.mpg.de (S.J. Ebel).

https://doi.org/10.1016/j.beproc.2019.103993

Available online 03 November 2019

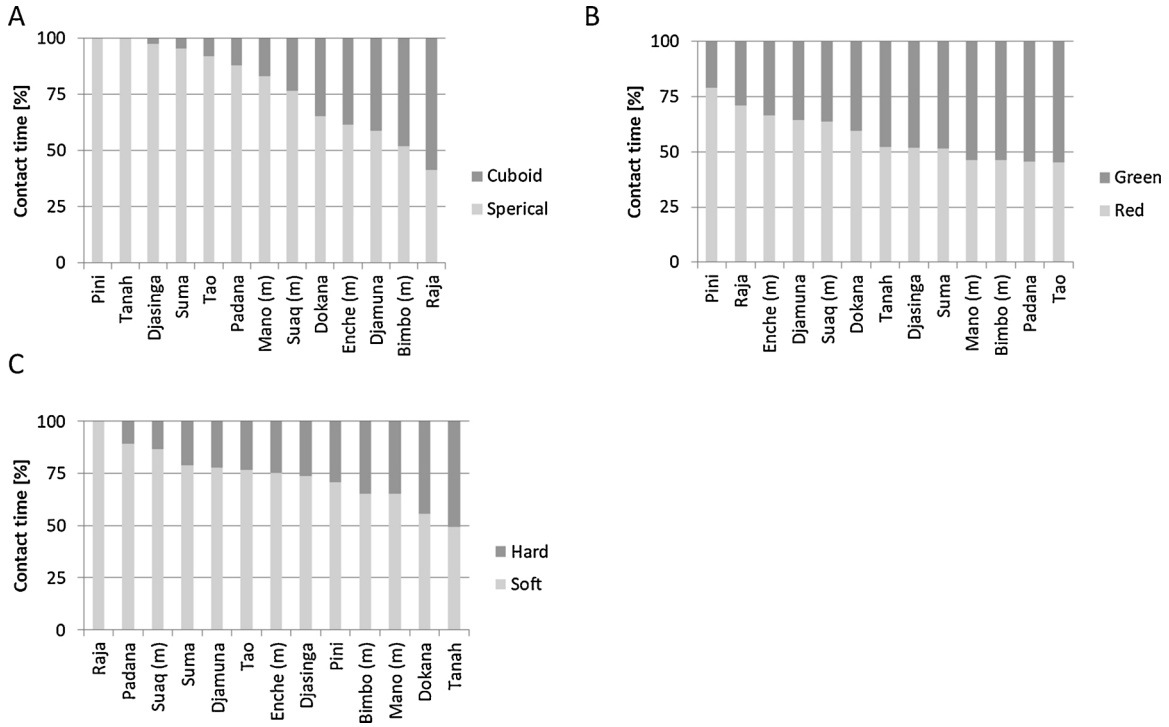

Fig. 1. Mean proportion of contact time with the objects as a function of shape (A), colour (B), and texture (C) for each subject.

with them (frequency of manipulation). We hypothesized a preference for 1) spherical over rectangular objects since like in humans, sharp transitions in contours may also represent a threatening stimuli for other primates (Bar and Neta, 2006); (2) red over green objects because this preference might reflect an evolutionary adaptation to detect red foods amongst green foliage (Dominy and Lucas, 2001); and 3) hard over soft objects as the former allow for more active manipulations such as banging, sliding, or throwing. We also explored sex-based differences in preference to better understand why primates in some studies differentially preferred human toys (Alexander and Hines, 2002; Hassett et al., 2008).

2. Methods

2.1. Subjects

We tested thirteen Sumatran orang-utans (*Pongo abelii*; 9 females, 4 males; age range: 3–36 years) from three German zoos: Leipzig Zoo/WKPRC ($N = 7$), Berlin Zoo ($N = 3$) and Dortmund Zoo ($N = 3$). All orang-utans were socially housed with access to indoor and outdoor enclosures. They were individually tested in their indoor rooms and neither food nor water deprived. The study complied with the "EAZA Code of Ethics" and all applicable national and international guidelines for behavioural research with primates.

2.2. Materials and procedure

Objects consisted of wooden blocks (34 mm x 34 mm x 80 mm) and wooden balls (diameter: 45 mm) coloured with red and green food colouring, respectively. To create soft objects, the wooden objects were wrapped in jute fleece (thickness: 3 mm), resulting in negligible weight differences between hard and soft objects regarding their shape or weight. Subjects received a total of twelve sessions with one session per day. In each session, two objects differing in one feature (i.e., shape, colour or texture) were placed fully visible in the indoor room (distance Leipzig and Berlin: 2.5 m, Dortmund: 1.2 m). The subject could freely explore them for five minutes. Four sessions were conducted for each condition (shape, colour, or texture), corresponding to all possible combinations of object features. Order of conditions and object side were counterbalanced across subjects. There were three missing sessions (shape, colour and texture condition) of three different subjects due to subjects` availability. All sessions were videotaped.

2.3. Analyses

We measured contact time and active manipulation using Solomon Coder (Péter, 2011). Manipulations, including drape, drop, hit, mouth, pick up, push/press, roll, rotate, rub, shift, sniff, throw, transfer and transport (modified from Torigoe, 1985) were coded using a one-zero sampling within five-second-intervals (Martin and Bateson, 2007), which were then summarized in a total manipulation score for each object. Coding was stopped after five minutes or when a soft object was unwrapped.

Linear mixed models (LMM) were performed in R (R Core Team, 2013) for each response, with sex, age, and shape and/or colour included as fixed effects, in addition to the interaction between either shape or colour, and sex. As random effects, the random intercepts of subject and zoo were included (see SOM for more details).

The overall preferences for the spherical, the red and soft objects were analysed by calculating 95% bootstrap confidence intervals (CI) for the intercept of each model. The proportion of the spherical, red or soft objects was considered to be significant when the lower confidence limit (CL_{lower}) was larger than 0.5 (proportion of the red and soft objects) and 0.79 (proportion of the spherical objects; arcsine(sqrt (0.5)) = 0.79). When a model revealed to be unstable with regard to zoo, calculating 95% bootstrap confidence intervals was repeated with excluding one zoo at a time.

3. Results

All orang-utans showed interest in the objects by touching and manipulating them (females: mean = 76%, SD = 12%, range = 48–88 %; males: mean = 51%, SD = 10%, range = 42–60 %; mean proportion of contact time with any of the objects across all sessions). Overall,

orang-utans touched the spherical objects significantly longer than the cuboid ones ($CI = [0.91, 1.55]$, lower limit (LL) > 0.79; Fig. 1A). Yet, this effect was driven by Leipzig Zoo contributing more than half of the sample (model without this zoo: $N = 6$; $CI = [0.66, 1.52]$, LL < 0.79). However, the remaining sample was quite small ($N = 6$), so that the results are difficult to interpret. Active manipulation, however, was significantly higher with balls than with blocks regardless of zoo ($CI = [1.10, 1.52]$, LL > 0.79). With regard to colour, we did not find a significant preference for red over green objects with respect to contact time ($CI = [0.45, 0.71]$, LL < 0.5; Fig. 1B), but we did find it with respect to manipulation frequency ($CI = [0.54, 0.79]$, LL > 0.5). Regarding texture, both contact time and frequency of manipulation indicated a preference for soft over hard objects ($CI = [0.55, 0.97]$ and $CI = [0.63, 0.96]$, LL > 0.5, resp.; Fig. 1C). Again, this effect in manipulation frequency was dependent on Leipzig Zoo (model without this zoo: $N = 6$; $CI = [0.21, 0.78]$, LL < 0.5).

Regarding sex differences on object preferences, only the shape model with active manipulation as response revealed significance (LMM; LRT: $\chi^2 = 23.51$, $df = 3$, $p < 0.001$): Males' preference for the active manipulation of spherical over cuboid objects tended to be stronger when both objects were red compared to when they were green, which was not the case for females (LRT for colour x sex: $\chi^2 = 3.16$, $df = 1$, $p = 0.075$). None of the other five models indicated a significant effect (LMMs; full-null-model comparisons with LRTs; shape: contact time, $\chi^2 = 1.08$, $df = 3$, $p = 0.782$; colour: contact time, $\chi^2 = 0.54$, $df = 3$, $p = 0.910$; manipulation, $\chi^2 = 5.62$, $df = 3$, $p = 0.131$; texture: contact time, $\chi^2 = 7.96$, $df = 7$, $p = 0.336$; manipulation, $\chi^2 = 8.96$, $df = 7$, $p = 0.256$).

4. Discussion

In the current study, captive orang-utans showed a preference for spherical over cuboid, red over green, and soft over hard objects, reflected by more frequent or diverse object manipulations. They often engaged in active play with the spherical objects, e.g. rolling them over the floor, chasing after them or throwing them into the air. This finding is consistent with a study in children showing a preference for toys that enable high motor activity levels (O'Brien and Huston, 1985). Humans and great apes also prefer roundish over angular shapes in eye-tracking studies (Jadva et al., 2010; Munar et al., 2015), perhaps reflecting an aversion for sharp transitions in contours reflecting potentially threatening stimuli (Bar and Neta, 2006). Round shapes also show more familiarity with food sources such as fruits than cuboid ones.

Orang-utans also preferred red over green objects. This finding corroborates with studies showing that children look longer at red than green (Franklin et al., 2010; Jadva et al, 2010). Assuming that trichromatic colour vision has evolved in the context of foraging for detecting ripe fruits and young leaves in front of green foliage (Dominy and Lucas, 2001; Lucas et al., 2003), a preference for the colour red should be expected for all trichromatic primates. Contrary to our findings, two recent studies in captivity found a preference for blue and green over red objects in chimpanzees and gorillas (Wells et al., 2008) and no colour preference in orang-utans (Mühlenbeck et al., 2015). The colour preference in the current study was less pronounced than the shape preference, and no coherent pattern for colour preferences has been found in human adults so far (e.g. Crozier, 1997; Whitfield and Whiltshire, 1990) so that future studies are needed to confirm consistent colour preferences in orang-utans.

Contrary to our prediction, orang-utans preferentially manipulated soft over hard objects, which often involved unwrapping the soft objects. This result might reflect a general tendency in captive orang-utans to decompose objects (Heuer and Rothe, 1998; Lethmate, 1977) or their specific interest in soft, decomposable objects, as they are often provisioned with food wrapped in cloth or paper for behavioural enrichment, rather than a preference for a soft texture.

We found no sex-based object preferences, unlike studies with vervet and rhesus monkeys (Alexander and Hines, 2002; Hassett et al., 2008). In these studies, females preferred a red pot, a doll and plush toys as they resembled features of monkey infants (red face, soft fur), while males preferred movable toys such as cars, because of their tendency to engage in active play. Importantly, the monkeys were tested in a group setting potentially allowing faster access to objects for some individuals. Here, orang-utans from both sexes, who were tested individually, preferentially manipulated red and movable objects, a finding consistent with evolutionary explanations (i.e., as a feeding adaptation and the preference for more active play). Yet, our sample included few males so that findings need to be interpreted cautiously. Another word of caution is needed as an individual's life experience with objects, which could not be reconstructed for the orang-utans in this study, might influence the development of preferences (e.g. Strauss et al., 2013). However, since our study comprises subjects of various ages from three populations, we consider it unlikely, although not entirely precluded, that the found object preferences are solely a product of learning. More research investigating preferences for basic object features such as shape, colour, and texture in primates may enable systematic comparisons between humans and nonhuman primates and help to understand the mechanisms underlying sex-based toy preferences.

The reported preferences for basic object features in orang-utans may influence the way they approach and interact with objects in their environment. These preferences are important for behavioural enrichment and the design of cognitive experiments to avoid biases in the results.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors have no competing interests to declare.

Ethics

The experiments conform to the 'Guidelines for the use of animals in research' as published in Animal Behaviour (1991, 41, 183-186).

Acknowledgements

Many thanks to Josep Call (MPI-EVA/WKPRC), André Schüle (Zoo Berlin), Ilona Schappert (Zoo Dortmund), the research assistants & zookeepers for their support; Colleen Stephens for statistical advice; Johanna Eckert for reliability coding.

References

Alexander, G.M., Hines, M., 2002. Sex differences in response to children's toys in nonhuman primates (*Cercopithecus aethiops sabaeus*). Evol. Hum. Behav. 23 (6), 467–479. https://doi.org/10.1016/s1090-5138(02)00107-1.

Barbiers, R.B., 1985. Orangutans' color preference for food items. Zoo Biol. 4 (3), 287–290. https://doi.org/10.1002/zoo.1430040309.

Bar, M., Neta, M., 2006. Humans prefer curved visual objects. Psychol. Sci. 17 (8), 645–648. https://doi.org/10.1111/j.1467-9280.2006.01759.x.

Crozier, W.R., 1997. The psychology of colour preferences. Surf. Coat. Int. 80 (12), 577–585.

Dominy, N.J., Lucas, P.W., 2001. Ecological importance of trichromatic vision to primates. Nature 410 (6826), 363–366. https://doi.org/10.1038/35066567.

Franklin, A., Bevis, L., Ling, Y., Hurlbert, A., 2010. Biological components of colour preference in infancy. Dev. Sci. 13 (2), 346–354. https://doi.org/10.1111/j.1467-7687.2009.00884.x.

Franklin, A., Pitchford, N., Hart, L., Davies, I.R.L., Clausse, S., Jennings, S., 2008. Salience of primary and secondary colours in infancy. Br. J. Dev. Psychol. 26 (4), 471–483. https://doi.org/10.1348/026151007x256672.

Furby, L., Wilke, M., 1982. Some characteristics of infants' preferred toys. J. Genet. Psychol. 140 (2), 207–219.

Hassett, J.M., Siebert, E.R., Wallen, K., 2008. Sex differences in rhesus monkey toy preferences parallel those of children. Horm. Behav. 54 (3), 359–364. https://doi.org/10.1016/j.yhbeh.2008.03.008.

Heuer, A., Rothe, H., 1998. Environmental enrichment for four subadult orangutans (*Pongo pygmaeus abelii*) in the Zoological Garden of Hanover. Zool. Gart. 68 (2), 119–133.

Higley, J.D., Hopkins, W.D., Hirsch, R.M., Marra, L.M., Suomi, S.J., 1987. Preferences of female rhesus monkeys (*Macaca mulatta*) for infantile coloration. Dev. Psychobiol. 20 (1), 7–18. https://doi.org/10.1002/dev.420200105.

Jadva, V., Hines, M., Golombok, S., 2010. Infants' preferences for toys, colors, and shapes: sex differences and similarities. Arch. Sex. Behav. 39 (6), 1261–1273. https://doi.org/10.1007/s10508-010-9618-z.

Lethmate, J., 1977. Problemlöseverhalten von Orang-Utans (Pongo pygmaeus). Paul Parey, Berlin, Hamburg.

Lucas, P.W., Dominy, N.J., Riba-Hernandez, P., Stoner, K.E., Yamashita, N., Loria-Calderon, E., Darvell, B.W., 2003. Evolution and function of routine trichromatic vision in primates. Evolution 57 (11), 2636–2643. https://doi.org/10.1554/03-168.

Martin, P., Bateson, P., 2007. Measuring Behaviour. An Introductory Guide. Cambridge University Press, Cambridge.

Mühlenbeck, C., Liebal, K., Pritsch, C., Jacobsen, T., 2015. Gaze duration biases for colours in combination with dissonant and consonant sounds: a comparative eye-tracking study with orangutans. PLoS One 10 (10), e0139894. https://doi.org/10.1371/journal.pone.0139894.

Munar, E., Gómez-Puerto, G., Call, J., Nadal, M., 2015. Common visual preference for curved contours in humans and great apes. PLoS One 10 (11), e0141106. https://doi.org/10.1371/journal.pone.0141106.

Neiworth, J.J., Hassett, J.M., Sylvester, C.J., 2007. Face processing in humans and new world monkeys: the influence of experiential and ecological factors. Anim. Cogn. 10 (2), 125–134. https://doi.org/10.1007/s10071-006-0045-4.

O'Brien, M., Huston, A.C., 1985. Activity level and sex-stereotyped toy choice in toddler boys and girls. J. Genet. Psychol. 146 (4), 527–533.

Péter, A., 2011. Solomon Coder (version Beta 12.09.04): a Simple Solution for Behavior Coding. Retrieved from. http://solomoncoder.com/.

R Core Team, 2013. R: a Language and Environment for Statistical Computing. Retrieved from. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/.

Sahgal, A., Pratt, S.R., Iversen, S.D., 1975. Response preferences of monkeys (*Macaca mulatta*) within wavelength and line-tilt dimensions. J. Exp. Anal. Behav. 24 (3), 377–381. https://doi.org/10.1901/jeab.1975.24-377.

Sireteanu, R., Encke, I., Bachert, I., 2005. Saliency and context play a role in infants' texture segmentation. Vision Res. 45 (16), 2161–2176. https://doi.org/10.1016/j.visres.2005.02.003.

Spering, M., Montagnini, A., Gegenfurtner, K.R., 2008. Competition between color and luminance for target selection in smooth pursuit and saccadic eye movements. J. Vis. 8 (15), 16.11–19. https://doi.org/10.1167/8.15.16.

Strauss, E.D., Schloss, K.B., Palmer, S.E., 2013. Color preferences change after experience with liked/disliked colored objects. Psychon. Bull. Rev. 20 (5), 935–943. https://doi.org/10.3758/s13423-013-0423-2.

Takeshita, H., Fragaszy, D., Mizuno, Y., Matsuzawa, T., Tomonaga, M., Tanaka, M., 2005. Exploring by doing: how young chimpanzees discover surfaces through actions with objects. Infant Behav. Dev. 28 (3), 316–328. https://doi.org/10.1016/j.infbeh.2005.05.009.

Torigoe, T., 1985. Comparison of object manipulation among 74 species of non-human primates. Primates 26 (2), 182–194. https://doi.org/10.1007/bf02382017.

Wells, D.L., McDonald, C.L., Ringland, J.E., 2008. Color preferences in gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes*). J. Comp. Psychol. 122 (2), 213–219. https://doi.org/10.1037/0735-7036.122.2.213.

Whitfield, T.W.A., Whiltshire, T.J., 1990. Color psychology - a critical-review. Genet. Soc. Gen. Psychol. Monogr. 116 (4), 385–411.

Williams, C.L., Pleil, K.E., 2008. Toy story: why do monkey and human males prefer trucks? Comment on "Sex differences in rhesus monkey toy preferences parallel those of children" by Hassett, Siebert and Wallen. Horm. Behav. 54 (3), 355–358. https://doi.org/10.1016/j.yhbeh.2008.05.003.