1   **Individual Differences in Task Participation in Wild Chacma Baboons**

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19   Despite the controlled testing conditions that are typical of captive environments, many evaluations

20   of animal cognition fail to ensure that all tested individuals participate. This is even more evident

21   under wild conditions, as animals are not restricted in their movement or social interactions and

22   have other activities available. In this study, we aimed to understand variation in cognitive task

23   participation in wild chacma baboons (*Papio ursinus*). We quantified individual differences in the

24   latency and likelihood to approach and explore two types of stimuli for two cognitive tests: a set

25   of coloured paper bags (in an associative learning test) and a blue cardboard square (in a second-

26   order conditioning test). We evaluated whether participation in each task was predicted by

27   individuals' phenotypic traits/states, as well as by two additional aspects of their behaviour: (*i*) the

28   availability of competing activities at the time of testing; and (*ii*) their propensity to exploit social

29   information. We found consistent results for both types of stimuli regarding the effect of age:

30   juveniles were more likely to contact the stimuli and explore them for longer. Similarly, for both

31   tasks, individuals involved in an activity at the time of testing were less likely to contact the stimuli

32   and had a lower exploratory time. Finally, juveniles and females with a high propensity to use

33   social information (i.e. scrounge) had a higher probability and shorter latencies to contact the paper

34   bags. Our findings not only highlight the potential bias cognitive studies conducted in the wild can

35   have, but also some of the individual attributes and external factors that determine task

36   participation.

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41 In recent years, much attention has been given to the quantification of individual differences in

42 cognitive behaviour (Boogert et al., 2018; Thornton & Lukas, 2012). Understanding such variation

43 is ultimately important, as differences are likely to result in important fitness consequences (Rowe

44 & Healy, 2014). Yet cognitive assessments commonly fail to adequately test all individuals'

45 cognitive abilities because not all individuals participate equally (Morton et al., 2013). Task

46 participation can be inconsistent both when approaching the task and engaging with it. In the first

47 case, participation requires an initial approach to the task that is not always achieved (e.g. keas,

48 *Nestor notabilis*: Gajdon et al., 2004; meerkat, *Suricata suricatta*: Thornton & Samson, 2012).

49 Krasheninnikova & Schneider (2014), for instance, reported that only 10 of 23 orange-winged

50 amazons (*Amazona amazonica*) entered a test room before 5 of these 10 individuals could

51 successfully complete a string-pulling task. In the second case, there has to be physical engagement

52 with a task for individuals to solve it (Huber & Gajdon, 2006). For example, successful completion

53 of a task in wild meerkats was determined by the time spent manipulating the test apparatus when

54 first presented (Thornton & Samson, 2012).

55 The scale of the participation problem is well illustrated by the patterns of task participation

56 reported in a broad range of studies summarised in Table 1. This table also shows how these studies

57 attempted to control for the two attributes commonly used to explain differences in participation:

58 neophobia, the aversion to novel stimuli (Greenberg, 2003), and the motivational state (from here

59 on: motivation), which modulates the aversion or attraction to a sensory stimulus based on the

60 outcome associated with such interaction (Rolls, 2005). These effects are normally controlled for

61 either experimentally (by habituating animals to the task beforehand, or by restricting food/water

62 prior to testing and/or using appetitive tasks, for neophobia and motivation respectively) or

63 statistically (through behavioural measures of neophobia or motivation included as control

64   variables). The patterns reported in this table indicate that task participation is uneven across a

65   variety of different taxa and cognitive tasks (23 different species, including 13 birds, 9 mammals

66   and 1 reptile, across 32 different types of task). However, perhaps the most notable pattern is that

67   low (or non-representative) levels of participation are most common under wild conditions: in wild

68   studies, a mean of 17% of individuals participated (free-ranging; n =13 tasks), compared to a mean

69   of 77% of individuals in other conditions (captive, wild-caught: n = 19 tasks). This likely reflects

70   the fact that, in the wild, test subjects cannot be completely isolated from other activities that

71   compete for attention with the task (Pritchard et al., 2016), nor can they be easily motivated via

72   food rewards or food/water deprivation prior to engage with the task (e.g. olive baboon, *Papio*

73   *anubis*: Laidre, 2008; *S. suricatta*: Thornton & Samson, 2012; vervet monkey, *Chlorocebus*

74   *pygerythrus*: van de Waal et al., 2010).

75   Addressing differences in task participation is important because our understanding of the

76   fitness consequences of variation in individuals' cognitive abilities will be determined by sampling

77   bias. As Table 1 highlights, studies evaluating certain groups, e.g. insects or fish, fail to report the

78   number of animals tested and participants, while other studies focus exclusively on the participation

79   of individuals who achieve the training criteria or on the participation of "successful" individuals.

80   For instance, Cole et al., (2011) reported that 44% of 570 wild great tits (*Parus major*) solved a

81   lever pulling task but it is unclear whether "non-solvers" attempted the task unsuccessfully or failed

82   to interact with the task at all. If the latter is true, then it is possible that performance was not

83   representative of individuals' cognitive abilities, but reflected bias caused by external factors.

84   Sampling biases may additionally differ between wild and captive studies, as different factors

85   influence participation in each setting. For instance, in the wild, some animals will be more or less

86   likely to participate depending on the current ecological conditions, while in captivity, participation

87   may vary according to differences in rearing or previous experience with novelty. Moreover,

88   although evaluations in the wild offer ecologically relevant conditions, fewer individuals

89   participate, making generalisations to the populations difficult (e.g. orangutans, *Pongo* spp. Forss

90   et al., 2015).

91 **Table 1** Differences in test subjects' participation in animal cognition studies and how those studies controlled for novelty and motivational effects.

Authors (ordered alphabetically)	Species	Experimental Setting	Task	Participation	Novelty control	Motivation control
Aplin et al., 2013	Great tits *P. major*	Wild-caught	Social learning task	91 out of 95 individuals participated	NEOPHOBIA: latency to approach the apparatus	Food rewards used during testing (i.e. food motivation); body condition
Ashton et al., 2018	Australian magpie *Cracticus tibicen dorsalis*	Free-ranging	Inhibitory control; associative and reversal learning; and spatial memory tasks	46 out of 56 individuals participated in all tasks: 56 in inhibitory control task; 48 in the associative and reversal learning tasks; and 49 in the spatial memory tasks	NEOPHOBIA: time elapsed between individual coming 5m of the apparatus, and first contact with it	Food rewards used during testing (i.e. food motivation)
Biondi et al., 2010	Chimago caracara *Milvago chimago*	Wild-caught	Problem-solving task	15 out of 18 participants touched and handled at least one object in the exploration test; all individuals approach the food in the neophobia test; all individuals approached the problem-solving task in the control session	Habituation to captive conditions NEOPHOBIA: latency to feed in trials with a novel object next to food EXPLORATION: latency time to approach three novel objects; contact latency; number of objects contacted; and total exploration time	Individuals tested in isolation to avoid social motivation (i.e. scrounging); food rewards used in each trial (i.e. food motivation)
Boogert et al., 2006	Starlings *Sturnus vulgaris*	Wild-caught	Extractive foraging task	15 out of 15 individuals interacted with the apparatus	Habituation to the apparatus NEOPHOBIA: neophobia test; latency to feed in a novel environment; latency to feed near a novel object	Food rewards used during neophobia test and in each trial (i.e. food motivation)
Boose et al., 2013	Bonobos *Pan paniscus*	Captive	Extractive foraging task	2 out of 14 individuals never interacted with the apparatus during observation time; 7 out of 14 did not interact with the apparatus in their first trial	Habituation to the apparatus	Food rewards used during testing (i.e. food motivation)

Authors (ordered alphabetically)	Species	Experimental Setting	Task	Participation	Novelty control	Motivation control
Carazo et al., 2014	Eastern water skink *Eulamprus quoyii*	Wild-caught	Spatial learning task	64 out of 64 individuals provided learning data	Habituation to testing enclosure and novel items	Food was provided *ad libitum* prior to the experiment but restricted during the first six days of testing; food rewards were introduced in trials; animals were chased to a "cold" refuge to promote return to "hot" refuge.
Cauchoix et al., 2017	Great tits *P. major*	Free-ranging and wild-caught	Reversal learning task	34 out of 54 wild individuals; 29 out of 29 captive individuals. MEASURED: logged on the device's antenna. 33 out of 34 wild individuals; 29 out of 29 captive individuals. MEASURED: pecking of the key at least once. 20 out of 34 wild individuals, 17 out of 29 captive individuals. MEASURED: complete 1st reversal training	Habituation to captive conditions; shaping with a dummy operant box for captive animals	Testing preceded by food deprivation
Cronin et al., 2014	Chimpanzees *Pan troglodytes*	Captive	Problem solving task	1 out of 15 individuals did not participate in all possible sessions; differences in task participation during training	Habituation to captive conditions and the device	No food or water deprivation; order of sessions was not predetermined
Dean et al., 2011	Ruffed lemurs *Varecia variegata* & *Varecia rubra*	Captive	Innovation tasks	38 out of 43 individuals contacted at least one of the 3 tasks presented; 33 out of 43 manipulated at least one task; 23 out of 43 solved at least one task.	None	Food rewards used in each trial (i.e. food motivation); no food deprivation before testing
Fagot & Bonté, 2010	Guinea baboons *Papio papio*	Captive	Alternative-forced choice; matching-to-sample tasks	20 out of 26 individuals in 2 experiments (6 were left out due to sickness or age). 12	Habituation to the device	No food deprivation. MEASURED: high levels of participation

Authors (ordered alphabetically)	Species	Experimental Setting	Task	Participation	Novelty control	Motivation control
				out of 20 in a 3rd experiment.		(298-774 trials); rewards were provided
Fagot & Paleressompoulle, 2009	Guinea baboons *Papio papio*	Captive	Motor control; abstract reasoning tasks	7 out of 8 individuals; participation inhibited by high-ranking conspecific.	Habituation to the device	No food deprivation. MEASURED: high levels of participation (95-112,729 trials); rewards were provided
Franks & Thorogood, 2018	Hihi *Notiomystis cincta*	Free-ranging	Associative learning task	78 out of 97 individuals visited the apparatus; 59 did not participate in the first stage of testing; 12 did not participate in the second stage of testing.	Habituation to the general characteristics of the apparatus	Food rewards used in each trial (i.e. food motivation)
Gajdon et al., 2004	Kea *N. notabilis*	Free-ranging	Problem-solving task; social learning	5 out of a maximum of 15 individuals approached the apparatus in both, the baseline and test phases.	None	Food rewards used during testing (i.e. food motivation)
Isden et al., 2013	Spotted-bowerbirds *Ptilonorhynchus maculatus*	Free-ranging	Barrier removal; novel motor; colour discrimination; color reversal; shape discrimination; spatial memory tasks	11 out of 19 individuals participated in all tasks; 5 failed to participate in all tasks; 3 in at least 1.	None	Food rewards used during training and in each trial (i.e. food motivation) MEASURED: time taken to move objects more than 20 cm away (barrier removal task); presenting a rewarded well with no colour cues
Krasheninnikova & Schneider, 2014	Orange-winged amazon, *A. amazonica*	Captive	Problem-solving string tasks	Tested individually: 10 out of 23 individuals entered test room; 7 out of 23 participated in the task; 5 out of 23 completed the task. Tested socially: 15 out of 35 participated in the task; 12 out of 35 completed the task	NEOPHOBIA: latency to feed from a novel feeder; latency until first contact with the string of the first task	Food rewards used during testing (i.e. food motivation)

Authors (ordered alphabetically)	Species	Experimental Setting	Task	Participation	Novelty control	Motivation control
Laidre, 2008	Olive baboons *P. anubis*	Free-ranging	Innovative food-access tasks	7 out of 62 individuals that approached the tasks interacted with them in the first day of testing; 1 out of 62 individuals that approached the tasks interacted with them in the last day of testing. Experiments ended if the individual failed to come within 5m of the apparatus for 10 min	None	Food rewards used during testing (i.e. food motivation)
Mirville et al., 2016	Australian magpie *Cracticus tibicen dorsalis*	Free-ranging	Associative learning task	28 out of 34 individuals contacted the task; 18 out of 34 flipped at least three lids on the grid MEASURED: individuals were considered participants if they approached and contacted the foraging grid	None	Food rewards used during testing (i.e. food motivation); food was visible during shaping but not during testing
Morand-Ferron et al., 2015	Great tits *P. major* Blue tits *Cyanistes caeruleus* Coal tits *Periparus ater* Marsh tits *Poecile palustris*	Free-ranging	Associative learning task	144 out of 2832 individuals visited the apparatus, of which: 88 were great tits; 43 blue tits; 3 were coal tits; and 10 were marsh tits. 80 out of 144 pecked the key, of which 67 were great tits; 8 blue tits; 4 were coal tits; and 1 were marsh tits	EXPLORATION: number and duration of flights, number of hops and areas explored during an 8 min assay in a novel environment	Food rewards used during testing (i.e. food motivation)
Sol et al., 2012	Common myna *Sturnus tristis*	Wild-caught	Consumer and motor innovation tasks	33 out of 60 individuals in both tasks	Habituation to captive enclosure and test cages; habituation to test apparatus. NEOPHOBIA: success of individuals who ate food next to a noel object; latency to start feeding; latency to approach feeder	Overnight food deprivation prior to morning tests MEASURED: latency to approach a food dish between initial and final phases

Authors (ordered alphabetically)	Species	Experimental Setting	Task	Participation	Novelty control	Motivation control
Thornton & Samson, 2012	Meerkat *S. suricatta*	Free-ranging	Innovative foraging task	63 out of 135 participants MEASURED: interaction with the apparatus	No habituation NEOPHOBIA: latency to the apparatus	Food rewards used during each trial (i.e. food motivation); presentations were made early morning
Titulaer et al., 2012	Great tits *P. major*	Wild-caught	Associative learning; behavioural flexibility	52 out of 54 individuals participated. MEASURED: individuals were considered participants if they lifted the covers from the apparatus.	EXPLORATION: time it took birds to reach 4 out of 5 trees in a novel environment; latency to approach a novel object and the closet distance at 120s.	Food deprivation on the day of testing; food rewards used during each trial (i.e. food motivation); food was not visible
Johnson-Ulrich et al., 2018	Spotted hyena *Crocuta crocuta*	Captive	Inhibitory control; innovation	10 out of 10 participants tested individually MEASURED: trials began when individuals entered the arena and ended when the task had been solved or after 15 min.	Habituation to the test apparatus (i.e. familiarization trials) NEOPHOBIA: latency to feed from the apparatus in the first familiarization trial	MEASURED: latency from the start of the trial to first contact with the apparatus; food rewards used in each trial (i.e. food motivation)
van de Waal et al., 2010	Vervet monkeys *C. aethiops*	Free-ranging	Social Learning; "artificial fruit"	64 out of 108 participants. MEASURED: individuals were considered participants if touched the apparatus	No habituation; demonstrator training	None
van Horik & Madden, 2016	Pheasants *Phasianus colchicus*	Captive	Extractive foraging task: Flip-top. Flip-cup & Petri-dish	184 out of 200 participants Flip-top & Flip-cup tasks; 83 out of 100 participants in Petri dish task MEASURED: individuals were considered participants if they acquired the base worm (BW); subjects who participated in a task, likely participated in the other	No habituation.	MEASURED: Time to acquire the food-item; order in which each individual entered the testing chamber; goal directed control. No food deprivation
van Horik et al., 2016	Pheasants *P. colchicus*	Captive	Novel motor skills; colour discrimination; colour reversal; shape	54 out of 144 participants in all possible test sessions. MEASURED: individuals interacting with the arena 120s after entering it;	Habituated and shaped to enter testing chamber. NEOPHOBIA: exploration of a novel environment; latency to	Food rewards used during shaping; food deprivation prior to testing; food reward was provided in each

Authors (ordered alphabetically)	Species	Experimental Setting	Task	Participation	Novelty control	Motivation control
			discrimination; spatial memory tasks.	attempt to obtain meal-worm	approach a novel object; latency to approach an unknown conspecific	task; shaping with food immediately prior to test. MEASURED: order each individual entered the testing chamber; time to acquire the freely-available food-item (i.e. food motivation)
Vonk & Povinelly, 2011	Chimpanzees *P. troglodytes*	Captive	Tool-use; gaze-following tasks.	No individual out of 7 participated in all tasks in the training and testing phases.	None	

92 Shown are the details of each study, including: (*i*) the authors and year of publication; (*ii*) common and Latin name of the species tested; (*iii*) the experimental

93 setting in which animals were tested: "free-ranging" refers to wild animals tested in their natural habitat, "wild-caught" refers to wild-born animals tested in

94 captivity and "captivity" refers to captive-born animals tested in captivity; (*iv*) the task animals were tested with; (*v*) the number of participants out of the

95 total sample tested, including different points of participation, and whether participation was directly measured; (*vi*) how the response to novelty was directly

96 measured in a test and/or controlled for in any way; (*vii*) how motivation was directly measured in the test and/or controlled for in any way. When authors

97 explicitly quantified participation and motivation in each experiment, we indicate it as "MEASURED". We additionally indicate whether authors explicitly

98 measured animals' novelty response as either "NEOPHOBIA" or "EXPLORATION".

99

100   In a small number of the cognition studies listed in Table 1, individual differences in task

101   participation have been associated with sex and age, presumably reflecting differences in

102   neophobia and/or motivation according to these phenotypic traits/states. For instance, van Horik

103   and colleagues (2016) reported that sex in interaction with body condition was a determinant of task

104   participation in captive pheasants (*P. colchicus*), with males of high body condition consistently

105   participating in a task and females of all conditions gradually increasing their participation.

106   Similarly, juvenile great tits were reported to participate in a task at a higher frequency than adult

107   conspecifics (Morand-Ferron et al., 2015), suggesting that juveniles may have lower neophobia

108   than adults in some species (*M. chimango*: Biondi et al. 2010; chacma baboons, *P. ursinus*: Carter

109   et al. 2014). Individual traits such as social rank may likewise determine participation for some

110   individuals (Laland & Reader, 1999). For example, low-ranking animals are likely hungrier

111   because their access to resources is constrained by high-ranking conspecifics; they may thus be

112   more motivated to interact with tasks that potentially offers food rewards. Higher-ranking

113   individuals on the other hand, are rarely restricted in their access to resources and may be less

114   motivated to engage with a task (Lee et al., 2016; Reader & Laland, 2001). Although studies

115   concerning trappability highlight the consistent effect of phenotypic traits and states in creating

116   sampling bias (Biro & Dingemanse, 2009; Carter et al., 2012), there are few cognitive studies that

117   have directly investigated sampling bias. One exception of the latter for instance, reports that the

118   training criteria, task participation and performance were all biased towards individuals with

119   specific personalities (capuchin monkeys, *Sapajus apella*: Morton et al., 2013).

120   There are two further factors that are rarely considered but that might affect an individuals'

121   motivation to participate in cognitive tasks in wild conditions compared to those carried out in

122 captivity. These are: (*i*) involvement in competing activities; and (*ii*) an individual's pattern of

123 information use. In the first case, individuals may be less motivated to participate when they are

124 already engaged in or distracted by other activities, like foraging (e.g. Cauchoix et al., 2017; van

125 Horik et al., 2016). In the second case, individuals may be less motivated to participate if they

126 usually learn about their environment through observing others rather than through their own

127 exploration, i.e., they prefer to use social information over personal information (Giraldeau &

128 Caraco, 2000). Individuals often differ in their propensity to generate and exploit information

129 (Giraldeau & Caraco, 2000, Carter et al., 2015), and those who typically rely on social information

130 ('scroungers') may be less willing to approach and explore novel locations, objects or stimuli on

131 their own.

132   The purpose of our study was to better understand the sources of individual variation in

133 participation in cognitive tasks in two groups of wild chacma baboons. We began by assessing the

134 potential influences of the three phenotypic traits/states commonly associated with the motivation

135 to participate in tasks: sex, age, and social rank. Following findings in previous studies described

136 above, we predicted that males (Altmann, 1974), juveniles (Morand-Ferron et al., 2015) and low-

137 ranking individuals (Reader & Laland) would have higher task participation because they are more

138 likely to be hungry and, thus, more likely to be motivated to interact with tasks that potentially

139 provide a food reward. We then explored two further phenotypic traits/states that are rarely

140 considered but could play an important role in the motivation to participate in tasks: involvement

141 in competing activities at the time of testing and the propensity to use social as opposed to personal

142 information. We predicted that individuals involved in low-engagement activities and who have a

143   propensity to use personal information would be more likely to interact with the tasks. Throughout

144   the analyses we also control for the potential effect of neophobia on task participation.

145   **METHODS**

146   *Study Site and Species*

147   This study was carried out on two fully-habituated troops (J and L Troops) of wild chacma baboons

148   at the Tsaobis Baboon Project, Tsaobis Nature Park (15° 45'E, 22° 23'S), Namibia, over two field

149   seasons (April-September 2015; May-September 2016). Troops ranged from 61-68 individuals in

150   2015 and from 47-51 individuals in 2016. Observers followed both groups of baboons on foot from

151   dawn to dusk, undertaking a series of experimental cognitive tasks and collecting observational

152   data from a sample of individuals across age-sex classes. Baboons in both troops were well-

153   habituated to observers and readily approach anthropogenic objects due to their generalist nature

154   (Bergman & Kitchen, 2009).

155   *Stimuli presentation*

156   As part of two cognitive tasks, an associative learning task and a second-order conditioning task,

157   we presented individuals with two types of stimuli. In the associative learning task, baboons were

158   presented with two sets of paper bags, one green and one red, which differed in value: one with

159   corn kernels inside (i.e. a highly preferred food reward) and the other with small corn kernel-sized

160   pebbles (i.e. no reward).We presented the sets of paper bags to a sample of 37 individually-

161   identifiable baboons (N = 41 and 44 in J and L troops, respectively) between July and September

162   2015 (Martina et al., unpublished data). Each individual was presented with the bags a total of three

163   times with a three-day interval between each presentation (mean; median re-test interval: 3.14; 3.00

164   days). The sample was selected to be representative of the general population aged over 3 years

165   old and encompassed baboons from all possible three-way combinations of dominance rank (high,

166   mid, and low), sex (female, male) and age class (juvenile, adult) (see Appendix 1 for a breakdown

167   of the test sample). All paper bag presentations were conducted between sunrise (0620-0647 h) and

168   1000 h (mean testing time: 0737 h) to ensure all individuals had similar levels of hunger. To keep

169   presentations within this schedule, we presented the paper bags to a maximum of six individuals

170   per day (median = 5, range = 3-6), the first of which was randomly selected based on opportunistic

171   encounters (e.g. 1 adult, mid-ranking female; or 1 juvenile, mid-ranking male). Afterwards,

172   individuals were opportunistically selected from the pool of available individuals in each of the

173   remaining three-way class combinations to be tested, with the restriction that once an individual

174   from a given class combination was tested, no further individuals from that class combination

175   would be tested that day. We avoided testing newly immigrated males not yet habituated to human

176   proximity (N = 1) and old/excitable adult females (N = 7), because neither were possible to

177   approach to within 2.5 m. We are cognisant that avoiding testing particular older females presents

178   a bias towards adult males and/or younger females; however, these individuals represented <10%

179   of the total population available to test. Additionally, the rewarded colour differed for each troop

180   (green in J troop, red in L troop) to control for any pre-existing preference the baboons might have

181   for a particular colour. An individual's colour preference could not be determined due to logistical

182   constraints. The position of the rewarded bag was randomized in each presentation.

183   The second stimulus, a single unrewarded blue cardboard square (20 x 20 cm) that was part

184   of a second-order conditioning task, was presented to a sample of 27 baboons over June-September

185   2016 (Martina et al., *in review*). This sample was divided into three groups (see Appendix 2):

186   Paired-Paired (P-P), consisting solely of individuals who had previously been presented with the

15

187 paper bag stimuli; and Paired-Unpaired (P-U) and Unpaired-Paired (U-P), both consisting of a

188 combination of individuals who had been presented with the paper bags and those who had not. In

189 total, 15 individuals were presented with both the paper bags and the blue cardboard square. As

190 was the case with the paper bags presentations, the pool of available individuals for testing was

191 identified using the same three-way combination of dominance rank, sex, and age class (see

192 Appendix 1), and the selection of individuals from that pool was based on opportunistic encounters

193 on the day of testing. For logistical reasons, presentations of the blue square were mostly limited

194 to one troop, resulting in 24 individuals being selected from L troop and 3 from J troop.

195   The entire task involved conditioning individuals over three phases. Each phase involved

196 three presentations with an average inter-trial interval of 57 min (range 20-227 min), such that a

197 total of nine presentations were made throughout a day. In the first two phases we presented two

198 pairings of stimuli, corn kernels with a clicker and a blue cardboard square with a clicker,

199 respectively, while in the last phase we presented individuals with a single blue cardboard square.

200 Only trials involving the blue square are analysed here, as all individuals readily approached the

201 corn kernels in the initial three presentations (median latency = 2 s).

202   For both the paper bags and cardboard square stimuli, presentations were made to

203 individuals when out of sight of conspecifics to avoid test subjects being displaced by dominant

204 animals before they could interact with the stimulus, or an audience learning socially by observing

205 others. In the case of the paper bags, C.M. and an assistant moved ahead of the foraging individual

206 and waited until it was out of sight of others, at which point the assistant, who was positioned to

207 record the presentation approx. 2 m ahead, indicated that assessment could start. The task stimulus

208 would then be dropped on the ground ahead of the baboon while it was looking away. In the case

209 of the blue cardboard square, C.M. conducted all presentations in a similar manner but without an

210   assistant. Presentations were filmed in their entirety (Canon Vixia HF R300), and data were

211   extracted from the digital film footage. See Appendix 2 for a detailed description of both tasks.

212   For each of the stimuli presentations, we evaluated two different measures of participation:

213   (1) The latency (s) to touch the stimulus, measured as the time between first detecting the stimulus

214   and first contacting it with one or both hands, where first detection was based on the initial

215   sustained movement (<3s) of an individual's head and/or gaze towards the stimulus, and

216   corroborated by subsequent repeated head movements (following Carter et al., 2016). (2) The

217   exploratory time (s), dedicated to the stimulus after contacting it, measured as the time individuals

218   spent in continuous contact with the stimulus, including biting, sniffing and statically holding it

219   (i.e. holding it but not actively exploring it) to when they dropped it and walked away (2 m distance

220   from the stimulus).

221   *Observational data collection*

222   A variety of observational data were collected to quantify the phenotypic traits and states of the

223   test individuals. Observers moved throughout the troop, using the freely available software

224   Cybertracker (www.cybertracker.org) on individual smart phones (Samsung Galaxy S4, Samsung,

225   Seoul, South Korea) to record dominance interactions *ad libitum*. Focal observations were used to

226   collect data describing individuals' foraging patterns and further aggressive/affiliative interactions.

227   Focal observations lasted 20-30 min, and no individual was observed more than once per day.

228   Study subjects tested only in 2015 (n = 22) and those tested both years of study (2015-2016; n =

229   15), were observed for two 30 min focal observations per month in each of four time periods (0600-

230   0900, 0900-1200, 1200-1500 and 1500-1800 h) generating a median of 4 h of observation per focal

231   individual per month. Those individuals that were tested only in 2016 (n = 12) were observed for

232 a maximum of 30 min in each time period in every month of study (with the exception of three

233 animals who could not be observed for one month), generating a median of 1 h per focal individual

234 per month. In total, each baboon tested was observed for a median of 14 h (range: 8-14 h) and 11.5

235 h (range: 3.5-15.5 h) in 2015 and 2016, respectively. During each focal observation we recorded:

236 (1) all activities in which focal individuals were involved; (2) all aggressive interactions between

237 the focal individual and its conspecifics; and (3) the foraging behaviour of the focal individual and

238 its food patch characteristics. All the behaviours recorded during focal follows can be found in the

239 Appendix 3.

240 *Phenotypic traits and states*

241 We tested whether individual variation in the motivation to participate in cognitive tasks was

242 predicted by three phenotypic traits/states, commonly associated with motivational differences: **sex**

243 (female/male), assigned by physical appearance, as baboons are sexually dimorphic; **age class**

244 (adult/juvenile), where adults were defined by menarche and canine development in females and

245 males, respectively; and **dominance rank**, determined from the dominance hierarchy, calculated

246 each year based on *ad libitum*-recorded aggressive interactions, using Matman (Noldus Information

247 Technology) and standardized from 0 to 1 to control for troop size (data from both years confirmed

248 strongly linear hierarchies, 2015: Landau's corrected linearity index $h'_{J\ TROOP} = 0.343$, $h'_{L\ TROOP} =$

249 0.412, $n_J = 946$, $n_L = 861$; 2016: $h'_{J\ TROOP} = 0.156$, $h'_{L\ TROOP} = 0.202$, $n_J = 1081$, $n_L = 1326$; $p < 0.001$

250 in all four cases). The two remaining measures of motivation comprised:

251 *Competing activities*

252 We classified individuals as involved in either a consummatory activity, i.e. when they were

253 foraging, drinking or grooming with a conspecific, or a non-consummatory activity, i.e. resting or

254 travelling. Whether an activity was consummatory or non-consummatory was determined

255 according to the associated reward (i.e. food items or social interaction). .

256 *Information use*

257 This was assayed through each individuals' propensity for using social information during

258 foraging, i.e., the "scrounging rate". Following previous studies to evaluate information use in this

259 population (e.g. Lee et al., 2016), this rate was calculated for each field season by recording the

260 proportion of times the focal individual joined (i.e. began foraging from) an occupied patch during

261 focal observations. A patch was considered *occupied* if the focal individual entered a patch where

262 (an)other conspecific(s) were actively foraging from it. We did not consider instances where

263 individuals joined a patch through an aggressive interaction, nor any aggressive interaction over

264 specific food items once the individual was inside the patch. A patch was considered any tree, shrub

265 or herb species (the full list of species is provided in the Appendix 4) according to the following

266 rules: in the case of trees, a patch could consist of a single tree or several trees if the canopies were

267 contiguous; in the case of herbs/shrubs, a patch could consist of a single plant or several if another

268 herb/shrub of the same species was within 5 m (following Marshall et al., 2012).

269 *Neophobia*

270 To control for the possibility that participation was determined by a neophobic rather than a

271 motivational response, individual variation in neophobia was assayed using an established

272 experimental approach in which individuals' responses to a novel food (an eighth of an apple dyed

273 blue in 2015 and three popped corn kernels in 2016) were assessed. An individual's neophobia was

274 determined based on the time spent inspecting the item (i.e. the time between approaching the item

275 and leaving or eating the item), where more neophobic individuals spent less time inspecting the

276 item. This measure was estimated once during each year of study (2015-2016), and has previously

277 been shown to be repeatable over three years ($r = 0.26$, $P = 0.02$: Carter et al., 2012). These

278 experiments were carried out by A.J.C. in 2015 and 2016 as part of a long-term study (for further

279 detail see: Carter et al., 2012; Carter et al., 2014)

280 *Ethical Note*

281 Our research and protocols were assessed and approved by the Ethics Committee of the Zoological

282 Society of London (BPE 727) and approved by the Ministry of Environment and Tourism in

283 Namibia (Research Permit 2015/2016). We contacted private and public landowners directly and

284 were given full permission to work on their land throughout the field season.

285 *Statistical Analysis*

286 Individual variation in participation was analysed in two ways (likelihood/latency to contact the

287 stimulus and exploration time of the stimulus following contact) separately for both stimuli. In each

288 case, we began with a simple model specifying our three 'typical' predictors of motivation (age,

289 sex, and rank) and neophobia (a control variable) as our predictors. We then sequentially added our

290 'novel' measures of motivation to these initial models: involvement in a high-value activity and

291 information use preferences (indexed by the scrounging rate). This sequential approach allowed us

292 to consider not only the direct effects of our novel measures but also their potential interactions

293 with our typical measures, without incurring a risk of overparameterisation. This approach

294 generated a total of 12 statistical models: six to evaluate the likelihood/latency to contact and

295 exploration of the paper bags (three each for the two response variables), and six to evaluate the

296 likelihood/latency to contact and exploration of the blue cardboard square (three each for the two

297 response variables). A summary of the variables included in each of the models fitted is available

298 in Figure 1 and Table 2. Below we provide additional information on how each model was fitted

299 according to the response variables. All analyses were conducted in the R environment (version

300 3.2.3, 2015). To reduce the possibility of committing Type I Errors, we adjusted the criterion of

301 significance using Bonferroni correction for the pair of models fitted (i.e. for likelihood/latency

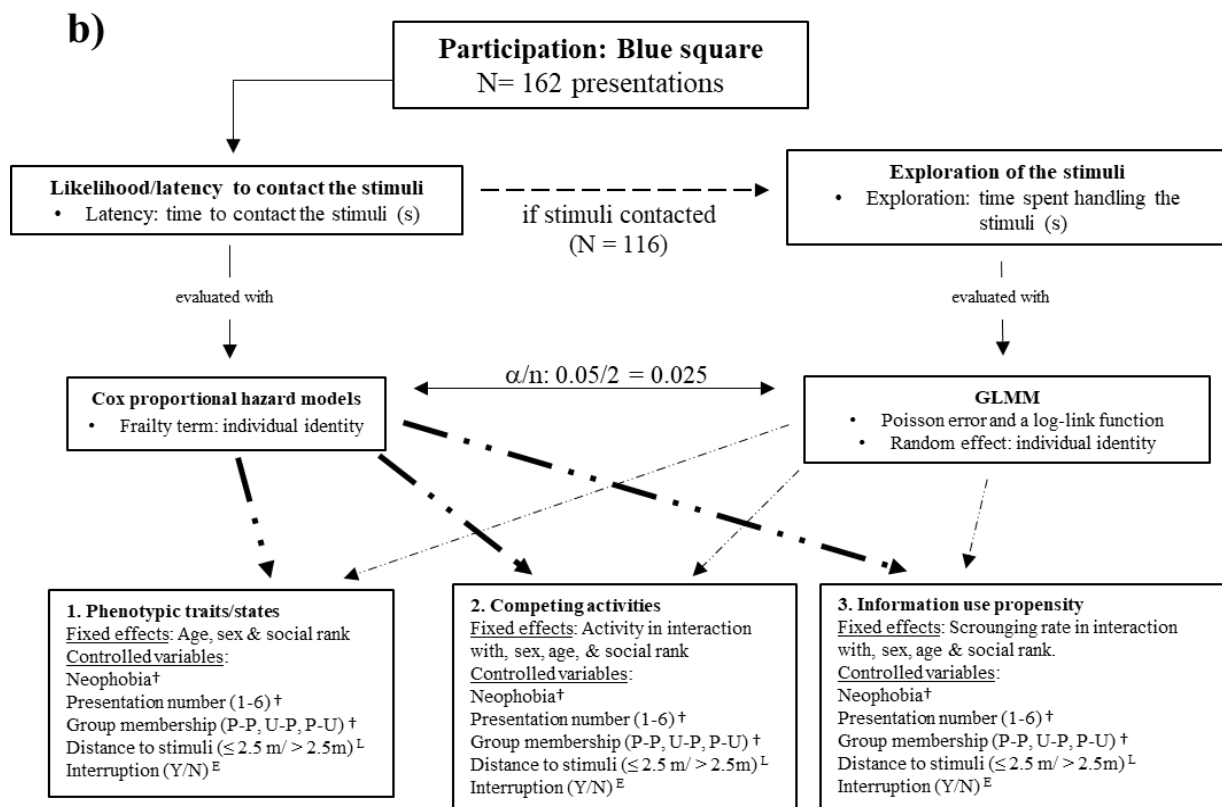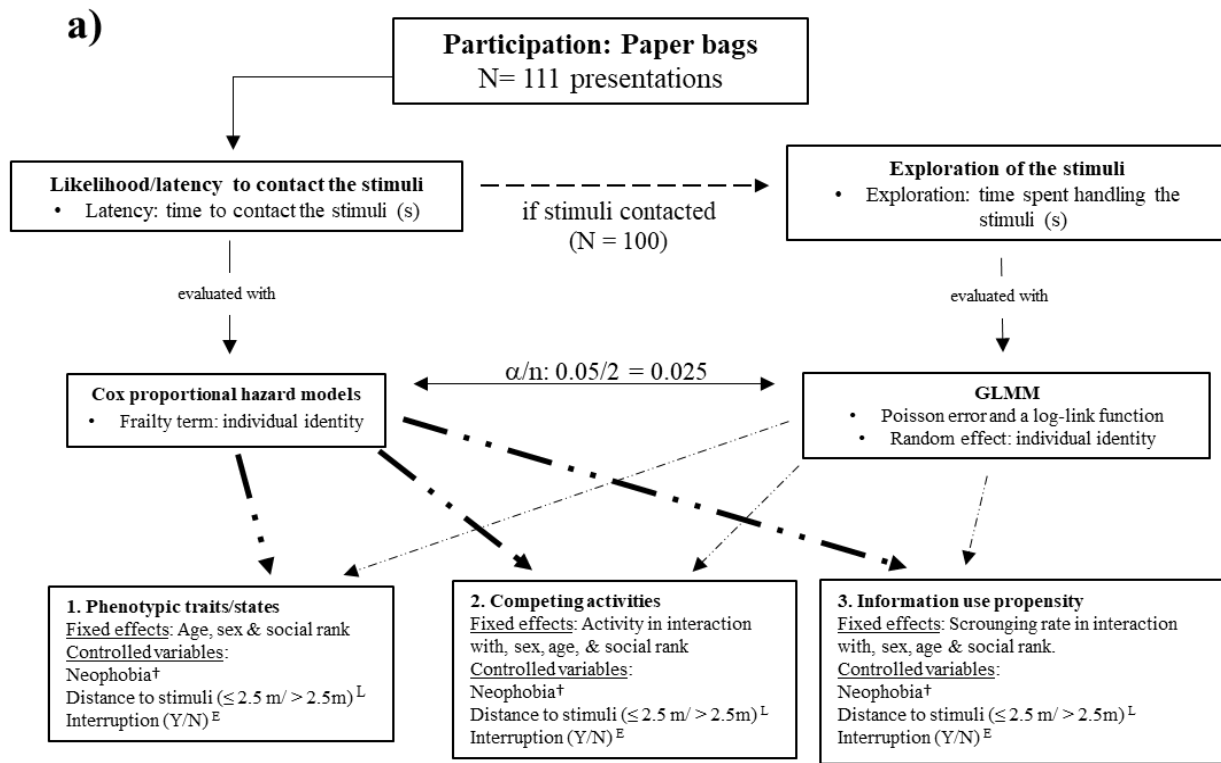302 and exploration) for each set of variables, for both types of stimuli. (α/n: 0.05/2 = 0.025).

303 *Likelihood/latency to contact the stimulus*

304 To evaluate the likelihood/latency to contact each stimulus, we fitted a series of Cox proportional

305 hazards models using the "survival" package (Therneau & Lumley, 2014). Survival models, such

306 as Cox proportional hazards regression, are used in time-to-event data analyses (Jahn-

307 Eimermacher, Lasarzik, & Raber, 2011) as they permit ceiling values to be included as censored

308 data points in those cases where individuals did not approach a task (Dean et al., 2011). Given the

309 opportunistic nature of our presentations, we were unable to standardise the distance at which either

310 type of stimuli was presented. To control for this, we included an estimate of the distance to the

311 stimulus ($\leq$2.5 m or >2.5 m) once detected, as a covariate. The paper bags were placed at an

312 estimated distance $\leq$2.5 m on 69 occasions and >2.5 m on 39 occasions. The blue cardboard square

313 was placed at an estimated distance equal to or within 2.5 m on 94 occasions and >2.5 m on 63

314 occasions. Additionally, models concerning the blue cardboard square included treatment group

315 (P-P, U-P, P-U) and trial number (1-6) as covariates (see Table 2). Individuals who contacted the

316 task through interrupting another conspecific's trial were excluded from all analyses (N = 7 for the

317 paper bags; N = 1 for the cardboard square). Spearman correlations, *r*, were calculated for all fixed

318 effects used in each model. Where co-variances were >0.70, the most relevant variable was chosen

319 (see Supplementary Material S1). Additionally, models were checked to see that they fit

320 assumptions appropriately. Backwards elimination of non-significant terms was used until a

321 minimal adequate model was obtained after which eliminated variables were then added back to

322 the final model to check they remained non-significant.

323 *Degree of exploration of the stimulus*

324 To examine the degree with which individuals examined each type of stimuli after contacting it,

325 we fitted Generalized Linear Mixed Effects Models (GLMM) using the package "lme4" (Bates et

326 al., 2015). Our initial sample (i.e. all individuals tested) was sub-setted to include only those

327 instances where individuals contacted the stimulus. There was no limit on exploratory time once

328 the stimulus was contacted. Interruptions of a presentations (Yes/No) was included as covariate in

329 all models, as was the treatment group (P-P, U-P, P-U) and trial number (1-6) in analyses regarding

330 the blue cardboard square (see Table 2). To facilitate convergence, quantitative predictor variables

331 were z-transformed to have a mean of zero and a standard deviation of 1. An Observation-Level

332 Random Effect was included if models showed over-dispersion. In each model, we used variance

333 inflation factors (VIFs) to evaluate multicollinearity, removing variables by stepwise selection

334 from the main model until all remaining variables had VIFs <2.0. Backwards elimination of non-

335 significant terms was used until a minimal model was obtained, after which the eliminated variables

336 were added back into the final model to check they remained non-significant.

a)

Participation: Paper bags
N= 111 presentations

Likelihood/latency to contact the stimuli
• Latency: time to contact the stimuli (s)

if stimuli contacted (N = 100)

Exploration of the stimuli
• Exploration: time spent handling the stimuli (s)

evaluated with

evaluated with

Cox proportional hazard models
• Frailty term: individual identity

α/n: 0.05/2 = 0.025

GLMM
• Poisson error and a log-link function
• Random effect: individual identity

1. Phenotypic traits/states
Fixed effects: Age, sex & social rank
Controlled variables:
Neophobia†
Distance to stimuli (≤ 2.5 m/ > 2.5m) ^{L}
Interruption (Y/N) ^{E}

2. Competing activities
Fixed effects: Activity in interaction with, sex, age, & social rank
Controlled variables:
Neophobia†
Distance to stimuli (≤ 2.5 m/ > 2.5m) ^{L}
Interruption (Y/N) ^{E}

3. Information use propensity
Fixed effects: Scrounging rate in interaction with, sex, age & social rank.
Controlled variables:
Neophobia†
Distance to stimuli (≤ 2.5 m/ > 2.5m) ^{L}
Interruption (Y/N) ^{E}

b)

Participation: Blue square
N= 162 presentations

Likelihood/latency to contact the stimuli
• Latency: time to contact the stimuli (s)

if stimuli contacted (N = 116)

Exploration of the stimuli
• Exploration: time spent handling the stimuli (s)

evaluated with

evaluated with

Cox proportional hazard models
• Frailty term: individual identity

α/n: 0.05/2 = 0.025

GLMM
• Poisson error and a log-link function
• Random effect: individual identity

1. Phenotypic traits/states
Fixed effects: Age, sex & social rank
Controlled variables:
Neophobia†
Presentation number (1-6) †
Group membership (P-P, U-P, P-U) †
Distance to stimuli (≤ 2.5 m/ > 2.5m) ^{L}
Interruption (Y/N) ^{E}

2. Competing activities
Fixed effects: Activity in interaction with, sex, age, & social rank
Controlled variables:
Neophobia†
Presentation number (1-6) †
Group membership (P-P, U-P, P-U) †
Distance to stimuli (≤ 2.5 m/ > 2.5m) ^{L}
Interruption (Y/N) ^{E}

3. Information use propensity
Fixed effects: Scrounging rate in interaction with, sex, age & social rank.
Controlled variables:
Neophobia†
Presentation number (1-6) †
Group membership (P-P, U-P, P-U) †
Distance to stimuli (≤ 2.5 m/ > 2.5m) ^{L}
Interruption (Y/N) ^{E}

337

338   **Figure 1** A flow chart indicating the statistical analyses made. The chart describes the components of our statistical

339   analyses for (a) the paper bags stimuli and (b) the blue cardboard square stimulus. Participation was evaluated with

340   two variables, likelihood/latency to the stimulus and exploration of the stimulus. If an individual contacted the stimulus

341   (slashed arrow, "if stimuli contacted"), then its subsequent exploration was evaluated. For both the Cox proportional

342   hazard models (dotted and slashed arrows in bold) and GLMMs (dotted and slashed arrows) we fitted three models.

343   For each stimulus, variables controlled in all models are marked with a cross (†); Variables marked with (L) indicate

344   controlled effects in models evaluating likelihood/latency to the stimulus. Variables marked with (E) indicate

345   controlled effects in models evaluating exploration of the stimulus.

346

347

Table 2 Summary of model design for each of the set of variables tested

Stimulus	Model	Response	Fixed Effects	Control Variables
Paper bags	MLatPB$_{Trait}$, MExpPB$_{Trait}$	Likelihood/latency, Exploratory time	Sex Age Social Rank Neophobia	Neophobia[†] Distance to Stimulus[L] Trial interruptions[E]
Paper bags	MLatPB$_{Activ}$, MExpPB$_{Activ}$	Likelihood/latency, Exploratory time	Activity* Sex Age Social Rank	Neophobia[†] Distance to Stimulus[L] Trial interruptions[E]
Paper bags	MLatPB$_{Info}$, MExpPB$_{Info}$	Likelihood/latency, Exploratory time	Scrounging rate* Sex Age Social Rank	Neophobia[†] Distance to Stimulus[L] Trial interruptions[E]
Blue cardboard square	MLatBS$_{Trait}$, MExpBS$_{Trait}$	Likelihood/latency, Exploratory time	Sex Age Social Rank	Neophobia[†] Trial number[†] Test group[†] Distance to Stimulus[L] Trial interruptions[E]
Blue cardboard square	MLatBS$_{Activ}$, MExpBS$_{Activ}$	Likelihood/latency, Exploratory time	Activity* Sex Age Social Rank	Neophobia[†] Trial number[†] Test group[†] Distance to Stimulus[L] Trial interruptions[E]
Blue cardboard square	MLatBS$_{Scroung}$, MExpBS$_{Scroung}$	Likelihood/latency, Exploratory time	Scrounging rate* Sex Age Social Rank	Neophobia[†] Trial number[†] Test group[†] Distance to Stimulus[L] Trial interruptions[E]

349 Shown are: (*i*) the name of the stimulus/i presented in each task; (*ii*) the name of the model, where MLat and MExp

350 indicate a Model for Latency and a Model for Exploration respectively, to approach the Paper Bags (PB) or Blue

351 Square (BS), and the subscript indicates the model focus (Trait, Activ, Info); (*iii*) the response variables used (in

352 separate models); and (*iv*) the fixed effects used. Variables marked with an asterisk (*) indicate interactions were

353 included between the asterisked fixed effect and each of the variables listed underneath. Variables marked with a cross

354 (†) indicate controlled effects included in all models and no interaction any of the other variables listed as "Fixed

355 effects". Variables marked with (L) indicate controlled effects in models evaluating likelihood/latency to the stimulus

356 and no interaction with any of the other fixed effects. Variables marked with (E) indicate controlled effects in models

357 evaluating exploration of the stimulus and no interaction with any of the other fixed effects.

358

359 **RESULTS**

360 *Paper bags stimuli:*

361 We presented paper bag stimuli on 111 occasions across 37 individuals (mean number of

362 presentations = 3; median = 3; range 1-3). In 100 out of 111 presentations, individuals approached

363 and contacted either one of the bags with a median latency of 2 s (range: 0-111 s). Out of 37

364 individuals tested, 8 did not contact the paper bags in at least one of three presentations and only 1

365 individual did not contact the bags in two presentations. All individuals who contacted the stimuli

366 explored at least one bag for at least 1 s (median: 20 s; range: 1-147 s). Of the 37 individuals tested

367 across 68 uninterrupted presentations, 6 had <5 s of exploratory behaviour in one of three

368 presentations, while 4 had <5 s exploratory behaviour in two presentations. On 32 occasions (29%

369 of all presentations) individuals were performing in a consummatory activity at the time of testing

370 (foraging on all occasions).

371 *Likelihood/latency to contact the paper bags*

372 All three models used to explore the likelihood/latency to contact the bags produced a minimum

373 adequate model (Table 3). In the first model (model MLatPB$_{Trait}$: $X^2 = 9.09$, df =1, $p = 0.001$), there

374 was a negative effect of age (Fig. 2a), with juveniles being more likely to contact the paper bags

375 and to do so sooner than adults. In the second model, our results indicated that individuals involved

376 in consummatory activities were less likely to contact the paper bags and do so at longer latencies

377 (Fig 2b; MLatPB$_{Activ}$: $X^2 = 10.01$, df =1, $p = 0.001$). In the third model (MLatPB$_{Info}$), there was an

378 effect of an individual's propensity to scrounge but the effect was dependent upon both age (Fig

379 2a & b: $X^2 = 10.16$, df =1, $p = 0.001$) and sex (Fig 3c & d: $X^2 = 5.28$, df =1, $p = 0.02$). In the first

380 case, individuals who more frequently used social information would approach the paper bags more

381 quickly if they were juveniles, whereas adults with a high scrounging rate approached more slowly.

382 In the second case, among scroungers, males were faster to approach than females, but slowed to

383 the same speed as females with higher scrounging frequencies. In the latter two models, we

384 additionally found a positive effect regarding the control variable of neophobia, where individuals

385 with low neophobia levels were more likely to contact the stimuli and do so at shorter latencies (p

386 $= 0.001$ in both cases; Fig 2c).

387 *Degree of exploration of the paper bags*

388 We found differences in two of the models testing exploration of the paper bags (Table 4). In the

389 first case, we again found a negative effect of age (MExpPB$_{Trait}$: $t = 3.33$, $p = <0.001$), where

390 juveniles spent more time exploring the bags than adults (Fig. 4a). In addition, in the second model

391 (MExpT1$_{Activ}$: $t = -2.27$, $p = 0.02$) baboons spent less time exploring at least one of the paper bags

392   after they had initially been engaged in a consummatory activity (Table 4; Fig. 4b). We found no

393   effect of propensity to scrounge on exploratory time (model MExpT1$_{\text{Info}}$).

394 **Table 3** Minimum adequate models obtained from the Cox proportional hazards analyses of factors affecting the likelihood/latency of baboons to contact a

395 set of paper bags.

	N_{obs}/ N_{events}	Coefficient	S.E. of Coefficient	Hazard Ratio	Chi-sq	Df	p
MLatPB$_{Trait}$[a]	106/98						
Age: Juvenile[1]		0.89	0.29	2.45	9.09	1	**0.002**
Distance: ≤ 2.5 m[2]		0.74	0.24	2.21	10.21	1	0.001
Frailty (Individual)					27.65	14.63	0.01
MLatPB$_{Activ}$[b]	103/98						
Activity: Consummatory[3]		-0.89	0.28	0.41	10.01	1	**0.001**
Neophobia[†]		0.01	0.003	1.01	9.68	1	**0.001**
Distance: ≤ 2.5 m[2]		1.10	0.26	1.10	17.77	1	<0.001
Frailty (Individual)					25.28	13.64	0.028
MLatPB$_{Info}$[c]	106/98						
Scrounging rate		-0.77	1.49	0.45	0.31	1	0.58
Age: Juvenile[1]		-5.15	1.88	0.005	7.44	1	**0.006**
Sex: Male[4]		4.32	1.98	0.75	4.75	1	**0.02**
Neophobia		0.007	0.002	1.00	5.60	1	**0.01**
Scrounging*Age		7.40	2.32	0.001	10.165.28	1	**0.001**
Scrounging *Sex		-5.58	2.43	0.003	12.18	1	**0.02**
Distance: ≤ 2.5 m[2]		0.78	0.22	2.19	0.00	1	<0.001
Frailty (Individual)						0	0.92

396

397 a: Variance of random effect = 0.27, I-Likelihood = -366.2, Likelihood ratio test = 61.66 on 16.08 df, p = <0.001
398 b: Variance of random effect = 0.24, I-Likelihood = -354.6, Likelihood ratio test = 70.97 on 16.01 df, p = <0.001
399 c: Variance of random effect = <0.001, I-Likelihood = -358.2, Likelihood ratio test = 40.83 on 7 df, p = <0.001

400 Shown are: (*i*) the name of the models; (*ii*) the covariates assessed; (*iii*) the regression coefficients; (*iv*) the standard errors (S.E.) of the regression coefficient;

401 (*v*) the hazard ratio; (*vi*) Chi-square values (Chi-sq); (*vii*) degrees of freedom (Df); and (*viii*) p-values (p). Significant results with values of $p < 0.025$

402 (excluding all control variables except neophobia) are highlighted in **bold**.[1] Reference category: Adult. [2] Reference category: >2.5 m. [3]Reference category:

403 Non-consummatory. [4]Reference category: Female
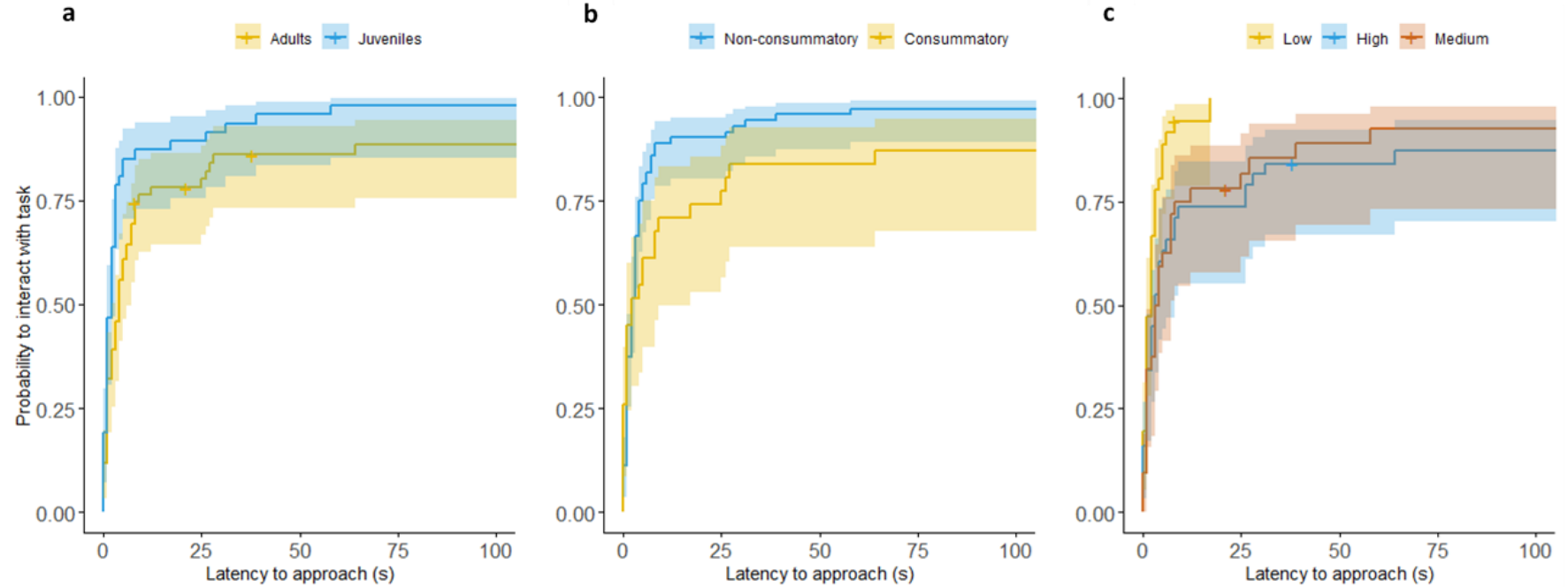
Figure 2 Individual differences in the likelihood/latency to contact two paper bags of different colour. The figure lines depict changes in the likelihood to interact with the paper bags with increasing latency to approach according to different (a) age classes (Adults & Juveniles); (b) competing activities (Non-consummatory & Consummatory); and (c) neophobia level. For graphical purposes, neophobia was grouped into three categories, "High", "Medium" & "Low". Shaded areas represent confience intervals.
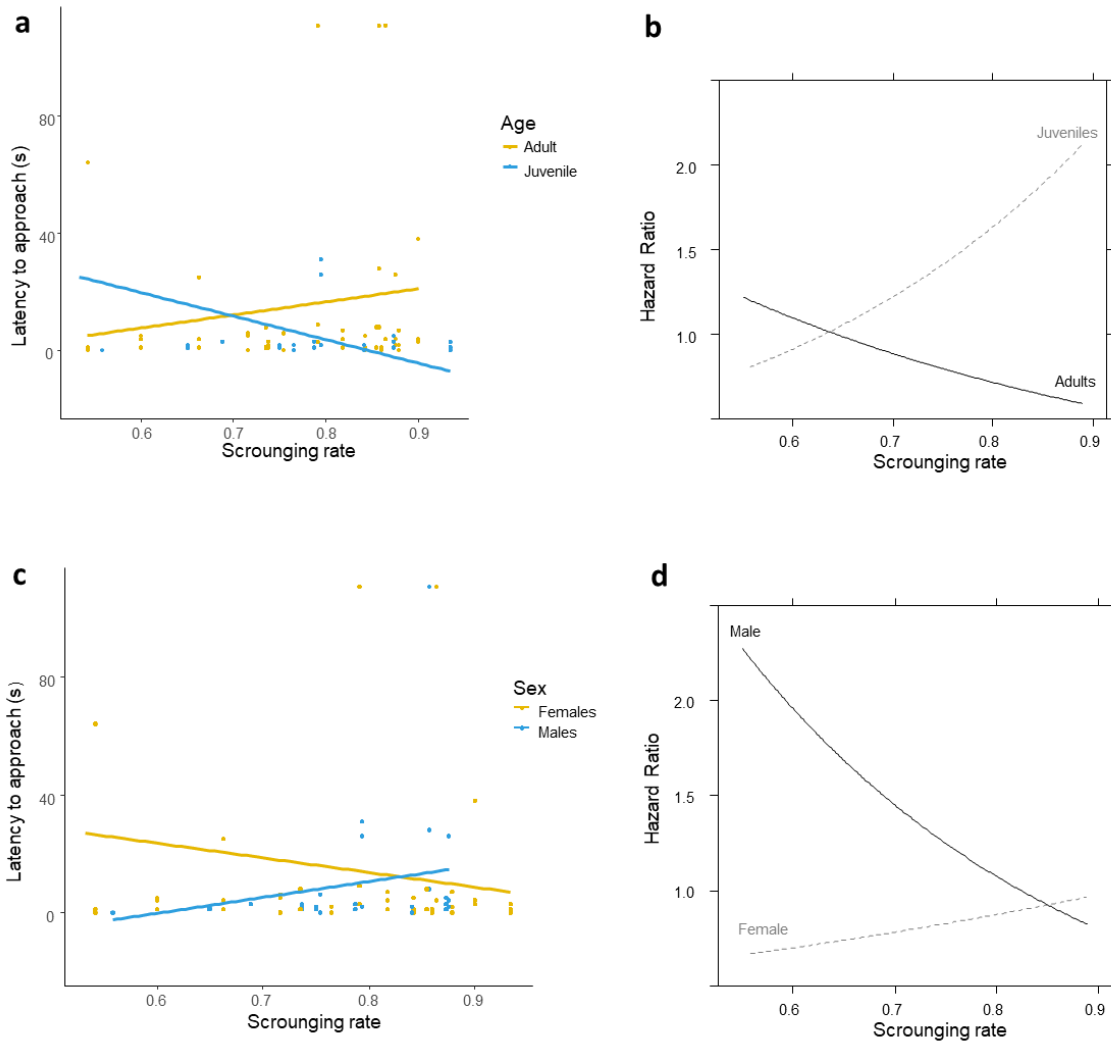
Figure 3 The interactions between the likelihood/latency to approach a stimulus and scrounging rate with age class and sex involving a stimulus of two paper bags of different colour. Shown are: (a) the interaction between the likelihood/latency to first contact with either one of the bags for juveniles (yellow) and adults (blue) in relation to their scrounging rate (raw data, each point represents an observation point from this experiment, n = 106); (b) interaction plot showing the hazard ratio of first contact with either bags for juveniles and adults relative to their scrounging rate; (c) interaction between the likelihood/latency to first contact with either one of the bags for males (shown in blue) and females (shown in yellow) in relation to their scrounging rate (raw data, each point represents an observation point, n = 106); (d) interaction plot showing the hazard ratio of first contact with either bags for males and females relative to their foraging-based scrounging rate. The hazard ratios were calculated from the Cox models (Table 3). The cumulative

418   hazard (i.e. hazard ratio) at a scrounging rate t shown in plots (b) and (d), represents the ratio of the likelihood of

419   contacting the paper bags where a high hazard ratio indicates a greater probability of contacting the paper bags. In

420   relation to plots (a) and (c), a high hazard ratio is associated with a lower latency to contact the stimuli

Table 4 Minimum adequate models from the GLMM analyses of the exploratory time of a set of paper bags

Model	N_{obs}/ N_{ind}	Term	Estimate	Std. Error	t	*p*
MExpPB$_{Trait}$	94/37	Intercept	2.44	0.17	14.02	
		Age: Juvenile[1]	0.78	0.23	3.33	**<0.001**
		Interruption: Yes[2]	-0.19	0.22	-0.84	0.36
MExpPB$_{Activ}$	93/37	Intercept	2.94	0.14	18.74	
		Activity: Consummatory[3]	-0.49	0.21	-2.27	**0.02**
		Interruption: Yes[2]	-0.25	0.21	-1.17	0.24

Shown are: (*i*) the name of the models; (*ii*) the number of observations and individuals for each model; (*iii*) the fixed effects of the minimal models, with their (*iv*) effect sizes (Estimate) and (*v*) standard errors (S.E.), (*vi*) test statistic (t) and (*viii*) p-values (*p*). Significant results with values of $p < 0.025$ are highlighted in bold. [1] Reference category: Adult. [2] Reference category: No. [3] Reference category: Non-consummatory.
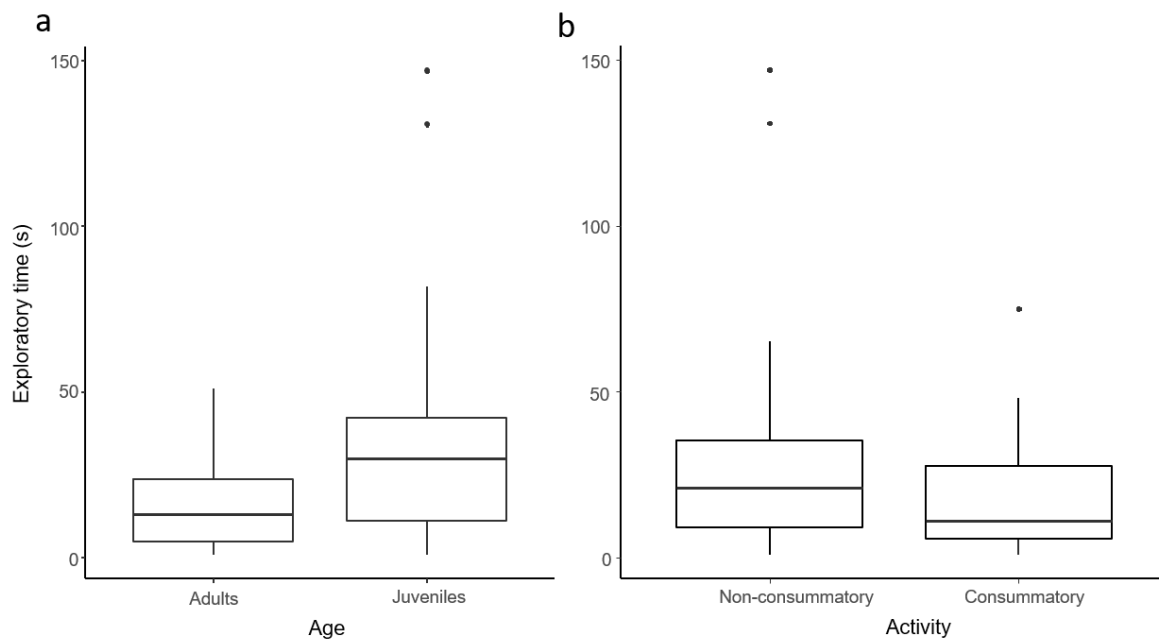
428   **Figure 4** Factors affecting individual differences in the exploratory time given to a set of two coloured bags. Shown

429   are (a) a boxplot of the exploratory time given to either bag and individuals' age class (Adult & Juvenile); and (b) a

430   boxplot of the exploratory time given to either bag and individuals' involvement in a competing activityat the start of

431   the trial (Non-consummatory & Consummatory). Total exploratory time was measured as the time individuals spent

432   handling, including sniffing and biting, either one of the stimulus bags. The horizontal line in each box indicates the

433   median, the box shows the lower (25%) and upper (75%) quartiles of the data, and the whiskers the minimum and

434   maximum values. The dots indicate outliers.

435

436   *Blue Cardboard Square stimulus:*

437   We carried out 162 presentations of the blue square (mean, median number of presentations = 6;

438   range 1-6) across 27 individuals. Individuals approached and contacted the square on 113 out of

439   162 presentations (median latency: 8 s; range: 0-300 s). A total of 20 out of 27 individuals failed

440   to contact the stimulus in at least one trial out of six; 6 of these individuals did not contact the

441   stimulus on 3 or more occasions. All individuals who contacted the blue square explored it for at

442   least 1 s (median: 7 s; range: 1-235 s). Of the 27 individuals tested across 110 uninterrupted

443   presentations, 18 individuals had <5 s of exploratory behaviour in at least one of three

444   presentations, while 10 individuals had <5 s exploratory behaviour in three or more presentations.

445   On 22 occasions (13%), individuals were involved in consummatory activities when they were

446   presented with the square (15 occasions foraging, 7 occasions grooming). For those individuals

447   who participated in both the paper bag and cardboard square tests (N=15), we compared the rates

448   of participation across stimuli (calculated both as the proportion of presentations in which the

449   subject contacted the stimulus, median and range: paper bag = 1.00, 0.50-1; blue square = 0.83,

450   0.33-1; and the average exploratory time (s) given to the stimulus if contacted, median and range:

451   paper bag = 25, 11-93; blue square = 10, 3-63). We found that the rates were positively correlated

452   for both measures of participation, but only achieved statistical significance in the latter (Spearman

453   rank correlations: proportion of contacts: P = 0.46, *p* = 0.08; median exploratory time: P = 0.54, *p*

454   = 0.03)

455   *Likelihood/latency to contact the blue cardboard square*

456   We found significant effects of competing activity on the latency to contact the blue square (Table

457   5). In this model (MLatBS$_{Activ}$: X^2 = 21.84, df =1, *p* = <0.001), individuals who were involved in a

458   consummatory activity at the time of testing had longer latencies to contact the cardboard square

459   than those who were not (Fig 5). In the first and third models, we found no relation between the

460   latency/likelihood to approach and either individuals' phenotypic traits/states and scrounging rate.

461   *Degree of exploration of the blue cardboard square*

462   In two out of three models ("standard" phenotypic/state traits and activity models), we found

463   significant effects of competing activities and age on the degree of exploration given to the blue

464   square (Table 6). In the first model investigating the main effects of phenotypic traits and states,

465   age affected exploratory time (MExpBS$_{Trait}$: *t* =3.61, *p* = <0.001), with juveniles exploring the

466   stimulus longer than their adult conspecifics, independently of other traits (Fig 6a). Similarly, in

467   the second model investigating the effects of competing activities (MExpBS$_{Activ}$: *t* =-2.21, *p* =

468   0.02), individuals who were engaged in a consummatory activity at the time of testing were less

469   likely to explore the stimulus (Fig 6b). Table 7 provides a summary of the results obtained for each

470   type of stimulus.

471 **Table 5** Minimum adequate models obtained from the Cox proportional hazards analyses of factors affecting the likelihood/latency of baboons to contact a

472 blue cardboard square.

473

	N_{obs}/ N_{events}	Coefficient	S.E. of Coefficient	Hazard Ratio	Chi-sq	Df	*p*
MLatBS$_{Activ}$[a]	119/113						
Activity: Consummatory[1]		-1.06	0.22	0.34	21.84	1	**<0.001**
Distance: ≤2.5 m[2]		0.51	0.20	1.67	6.38	1	0.01
Trial number		-0.15	0.19	0.86	0.60	1	0.44
Group: PU		0.002	0.28	1.00	0.00	1	0.99
Group: UP		-0.34	0.28	0.70	1.51	1	0.22
Frailty (Individual)					9.42	6.04	0.15

474 a: Variance of random effects = 0.08, I-Likelihood = -422.7, Likelihood ratio test = 40.02 on 10.28 df, *p* = <0.001

475 Shown are: (*i*) the covariates assessed; (*ii*) the regression coefficients; (*iii*) the standard errors (S.E.) of the regression coefficient; (*iv*) the hazard ratio; (*vi*)

476 Chi-square values (Chi-sq); (*vii*) degrees of freedom (Df); and (*vii*) *p*-values (*p*). Significant results with values of $p < 0.025$ are highlighted in **bold.** [1]

477 Reference category: Non-consummatory. [2]Reference category: >2.5 m.

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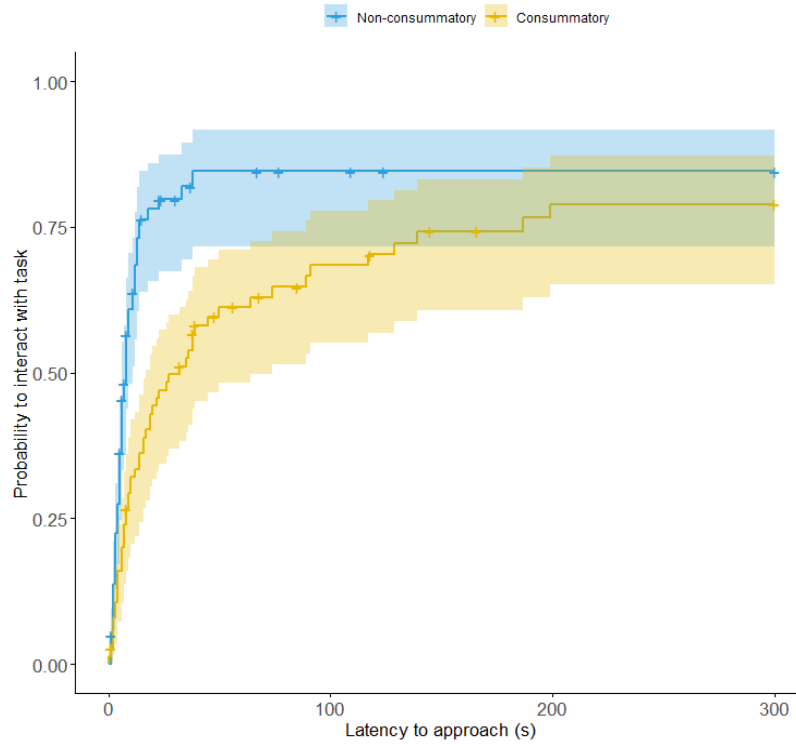
Figure 5 Individual differences in the latency to approach a a blue cardboard square. The figure lines depict changes in the likelihood to interact with the blue cardboard square with increasing latency to approach the stimulus depending on whether or not the baboons were involved in a non-consummatory or consummatory competing activity at the time of testing. Shaded areas represent confidence intervals.

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492 **Table 6** Minimum adequate models from the GLMM analyses of the exploratory time of a blue cardboard square.

Model	N_{Obs}/ N_{Ind}	Term	Estimate	Std. Error	t	p
MExpBS$_{Trait}$	116/26	Intercept	3.37	0.57	5.88	
		Age: Juvenile[1]	1.00	0.27	3.61	**<0.001**
		Trial number	-0.56	0.19	-2.95	<0.001
		Group: PU	-0.26	0.33	-0.79	0.42
		Group: UP	-0.37	0.33	-1.14	0.25
		Interruption: Yes[2]	0.91	0.44	2.05	0.04
MExpBS$_{Activ}$	115/26	Intercept	4.27	0.57	7.41	
		Activity: Consummatory[3]	-0.47	0.21	-2.21	**0.02**
		Trial number	-0.66	0.18	-3.54	<0.001
		Group: PU	-0.30	0.40	-0.75	0.44
		Group: UP	-0.47	0.40	-1.17	0.24
		Interruption: Yes[2]	1.27	0.47	2.67	0.007

493   Shown are: (*i*) name of the models; (*ii*) the response variable assessed; (*iii*) the number of observations and individuals

494   for each model; (*iv*) the fixed effects of the minimal models (Term); (*v*) effect sizes (Estimate); (*vi*) standard errors

495   (S.E.); (*vii*) test statistic (t); and (*viii*) *p*-values (*p*). Significant results with values of $p < 0.025$ (excluding the control

496   variables) are highlighted in **bold**. [1] Reference category: Adult. [2] Reference category: Non-consummatory. [3]Reference

497   category: No.

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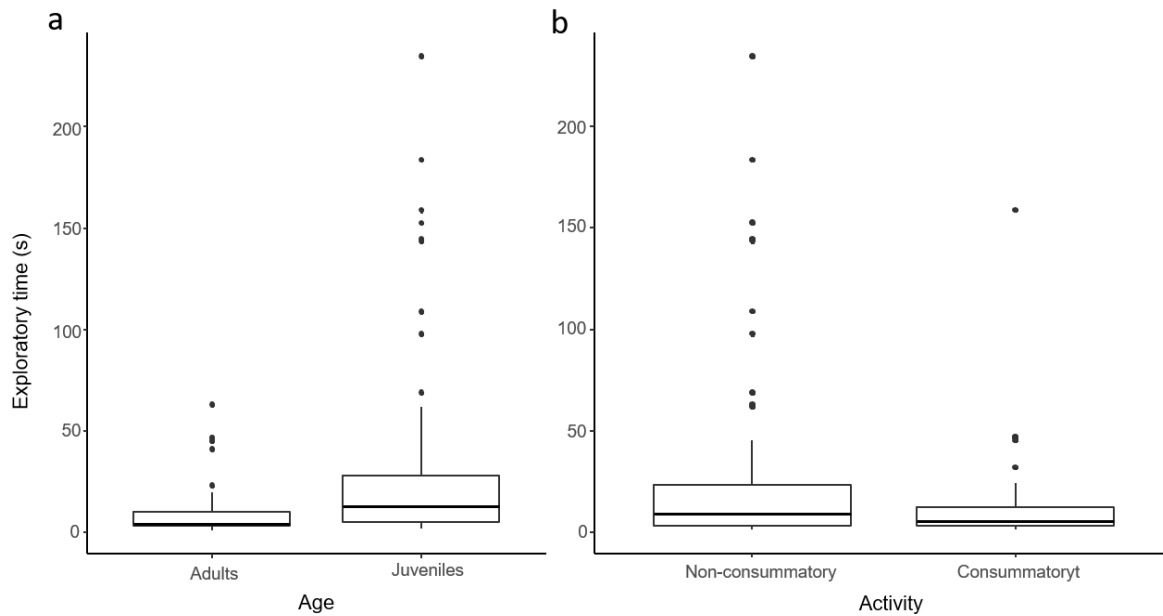
499   **Figure 6** Individual differences in the exploration time given to a blue cardboard square. Shown are (a) a boxplot of

500   the exploratory time given to the blue square according to age class (Adult; Juvenile); and (b) a boxplot of the

501   exploratory time given to the blue square according to whether individuals were engaged in a non-consummatory or

502   consummatory activity at the time of testing. Total exploratory time was measured as the time individuals spent

503   handling, including sniffing and biting, either of the bags. The horizontal line in each box in figure (b) indicate the

504   median, the box shows the lower (25%) and upper (75%) quartiles of the data, and the whiskers the minimum and

505   maximum values. The dots indicate outliers.

Table 7 Summary of the model outputs for two cognitive tasks involving a set of coloured paper bags and a blue cardboard square, respectively

Stimulus	Model	Response	Table	Figure	Activity	Scrounge	Sex	Age	Rank	Neophobia
	$MLatPB_{Trait}$	Latency	3	2	na	na	/	**Yes**	/	/
	$MExpPB_{Trait}$	Exploration	4	4	na	na	/	**Yes**	/	/
Paper bags	$MLatPB_{Activ}$	Latency	3	2	**Yes**	na	/	/	/	**Yes**
	$MExpPB_{Activ}$	Exploration	4	4	**Yes**		/	/	/	**Yes**
	$MLatPB_{Info}$	Latency	3	3	na	**Yes**	**Yes**	**Yes**	/	/
	$MExpPB_{Info}$	Exploration	4	/	na	/	/	/	/	/
	$MLatBS_{Trait}$	Latency	5	/	na	na	/		/	/
Blue cardboard square	$MExpBS_{Trait}$	Exploration	6	6	na	na	/	**Yes**	/	/
	$MLatBS_{Activ}$	Latency	5	5	**Yes**	na	/	/	/	/
	$MExpBS_{Activ}$	Exploration	6	6	**Yes**	na	/	/	/	/
	$MLatBS_{Info}$	Latency	5	/	na	/	/	/	/	/
	$MExpBS_{Info}$	Exploration	6	/	na	/	/	/	/	/

507 Shown is a summary of the main findings in this study, including: (*i*) the stimulus assessed; (*ii*) the name of each model; (*iii*) the response variable evaluated

508 in each model; (*iv*) the table in which the results of each model can be found; (*v*) the corresponding figure for the results found in each model; and (*vi*) the

509 presence of a significant predictor in each model according to the four hypotheses tested. "Na" indicate that the variable was not included in the particular

510 model. Slashes (/) indicate non-significance ($p = {<}0.025$) in that model.

DISCUSSION

In this study, we evaluated individual variation in the motivation to participate in two cognitive tasks related to: (1) "standard" phenotypic traits/states; (2) competing activities at the time of testing; and (3) the information use propensities of individuals. Before considering the implications of our findings in more detail, we will address the notable inconsistencies that we found between the significant predictors for the two types of stimuli presented. One possible explanation for the difference in the latency/likelihood to approach the stimulus in each task may be partly because one offered a reward (paper bags), while the other did not during the first encounter (blue cardboard square). Thus, it is likely individuals were more motivated to approach and/or explore the paper bag stimuli because the payoff was greater. Support for this explanation comes from the differences in the overall numbers of contacts with the stimuli (100/111 (90%) in the case of the paper bags; 116/162 (72%) in the case of the blue cardboard square). An alternative possibility may be that the presentation of the set of bags was separated by three days, while all presentations of the blue cardboard square were completed on a single day in the life of each animal. As such, it is possible that other untested variables (e.g. daily food intake) determined individuals' motivation to participate on the day they were tested.

Inconsistencies in the predictors may point to a further complication of cognitive testing procedures, namely that approaching a stimulus and subsequently exploring it may represent unique steps that are affected by particular traits/states differently. For example, in spotted hyenas, the initial approach towards a task may be more affected by neophobic responses, whilst exploration of that task may be driven by traits such as age or rank (Benson-Amram & Holekamp, 2012). The level of participation may additionally be determined by

534   task complexity, as some tasks (e.g. foraging boxes: Amici et al., 2020; multi-access box:

535   Johnson-Ulrich et al., 2018), require extensive manipulation and/or motor diversity to

536   complete. Such engagement may too be influenced differently by individuals' traits/states.

537   Further consideration of this hypothesis is beyond the scope of this study, as there are only

538   two types of stimuli and two response variables from which to draw comparisons. It is also

539   worth noting that both years of testing were characterized by a drought period; however, the

540   blue cardboard square was presented at the peak of the drought, when animals' foraging time

541   budgets were considerably greater (unpublished data), affording less time to engage with the

542   stimulus. Thus, it is possible that inconsistencies between stimuli/responses may have been

543   partly caused by ecological conditions in each year of testing. Nevertheless, we found a

544   persistent effect of individuals' phenotypic traits and states, competing activities and

545   information use propensities, the latter in interaction with two of the phenotypic traits. We

546   discuss each of these findings below.

547   *How Is Participation Influenced By Individuals' Phenotypic Traits/ States?*

548   A consistent pattern throughout the analyses was the effect of age on individuals' motivation

549   to participate in the tasks, seen in both the likelihood/latency to contact the stimuli and their

550   subsequent exploration. For both types of stimuli, juveniles showed higher motivation to

551   participate, being both more likely to contact the paper bags at shorter latencies, and

552   subsequently having a higher degree of exploration than adult conspecifics for both types of

553   stimuli. These results are consistent with other findings. For example, juveniles were more

554   exploratory of a novel cognitive task in both wild meerkats (Thornton & Samson, 2012) and

555   spotted hyenas (Benson-Amram and Holekamp 2012), and the exploration and likelihood of

556   interaction with novel objects, particularly those that offered no reward, decreased with age

557 in macaques (*Macaca sylvanus*: Almeling et al., 2016). Such a finding may reflect two

558 aspects of juveniles' behaviour and environments: (1) their highly exploratory nature

559 compared to adults (Biondi et al., 2010); and (2) their limited access to resources (Johnson

560 & Bock, 2004). In the first case, young animals may be more exploratory because they need

561 to acquire information in their early life due to their relative inexperience (Biondi et al.,

562 2010). Building on this, in the second case, juveniles are often poor competitors (Reader &

563 Laland, 2001) as they lack experience to successfully locate and/or exploit food items (e.g.

564 European blackbird, *Turdus merula*: Desrochers, 1992; *P. ursinus*: Johnson & Bock, 2004;

565 bottlenose dolphin, *Tursiops* cf. *aduncus*: Patterson et al., 2016). Taken together, our results

566 may reflect these limitations and explain juveniles' greater motivation to approach and/or

567 engage with novel objects (Kendal et al., 2005; Reader & Laland, 2001). The degree of

568 exploration given to the blue cardboard square may further reflect juveniles' motivation to

569 explore and sample their environment (Franks & Thorogood, 2018), even in the absence of

570 food rewards (Benson-Amram & Holekamp, 2012). Ultimately however, the phenotypic

571 traits/states that influence participation in some cognitive tasks may be different for others

572 depending on the reward form each task provides. To the best of our knowledge, no study

573 has directly investigated the relationship between individual differences in participation and

574 the type of reward; however it is possible that other traits/states are important determinants

575 of participation in tasks that offer other types of rewards, for instance, access to mates or

576 predator avoidance.

577 *Do Competing Activities Influence Participation?*

578 The availability of a competing activity affected individuals' participation in the latency to

579 contact both the paper bags and the blue square as well as the exploratory time given to both).

580   This suggests that, in general, individuals who are involved in "consummatory" activities at

581   the time of testing can be less motivated to participate. The effect may have been particularly

582   strong in this study because of the prevailing drought: deviating attention from scarce

583   resources would have been costly at this time. To the best of our knowledge, the large

584   majority of studies have not quantified the relationship between competing activities at the

585   time of testing and task engagement (but see: Fagot and Bonté 2010). This is an important

586   effect to consider, as some activities may offer benefits that are not necessarily substituted

587   by interacting with a task, for instance, socializing or foraging on preferred foods. In captive

588   conditions, there may be fewer opportunities to engage in activities that compete for

589   individuals' attention (Cauchoix et al., 2017); however, individuals' participation in captivity

590   is likely affected by the stress of social isolation and/or the testing environment *(e.g. C.*

591   *crocuta*: Johnson-Ulrich et al., 2018; *P. troglodytes*: Vonk & Povinelli, 2011). Further

592   exploration of this trade-off should consider the inclusion of competing activities during

593   testing, as it may better represent animals' decisions under natural conditions and potentially

594   buffer stress responses (Millidine et al., 2006)

595   *Are Scroungers More Likely To Participate?*

596   Participation with the paper bags was predicted by individuals' use of social information in

597   interaction with their phenotypes/states. Specifically, propensity to scrounge determined the

598   latency and likelihood to approach the paper bags. Much of the previous work investigating

599   information use strategies in relation to animal cognition has focused on how information

600   use affects cognitive performance (e.g. *P. major*: Aplin and Morand-Ferron 2017) rather than

601   participation. However, these previous studies also suggest a role of information use

602   strategies in individuals' motivation to engage with a task (e.g. Aplin & Morand-Ferron,

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603   2017; Giraldeau & Lefebvre, 1986). For instance, Aplin & Morand-Ferron (2017) showed

604   that in great tits scroungers had longer latencies to contact and learn a foraging task in a wild

605   bird population. The lack of studies linking information use with differences in participation

606   is surprising, as participation will invariably determine subsequent performance, as well as

607   bias a sample in favour of those individuals who are more likely to generate information

608   (Katsnelson et al., 2011).

609   In the case of age, juveniles who generate information (i.e. producers) approached the

610   paper bags at longer latencies than adult producers. This is contrary to our expectation but

611   may reflect an influence of the social environment on juveniles' decision-making. It may be

612   that producers are more likely to be alone than scroungers. Because of their smaller body size

613   compared to adults, juvenile baboons who are more frequently alone may be at a greater risk

614   from threats or predation (Johnson & Bock, 2004) and less willing to engage with novelty

615   compared to adults, particularly when the quality and/or accessibility of any potential reward

616   is unknown. Alternatively, personally finding food patches may be less costly for adults than

617   for juveniles, as adults have already acquired the necessary skills to forage efficiently, leading

618   to potential differences in task participation due to different time budgets (Johnson & Bock,

619   2004; Patterson et al., 2016). In the case of sex, female producers took longer to approach

620   the paper bags compared to male producers. A similar explanation may apply in terms of risk

621   management: smaller-bodied females who spend time foraging alone may avoid unnecessary

622   risks compared to larger-bodied males. The fact that adults and males were generally less

623   likely to contact the stimuli suggests that they may have less need to approach and investigate

624   novel objects for food items (Morand-Ferron et al., 2011). It is possible there are some

625   motivational aspects related to scrounging in each of the stages of task participation. For

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626   example, individuals with a high propensity for social information may be less likely to

627   approach novel objects because they already have greater opportunity to exploit resources

628   using social cues, but if they do, they can afford to spend time exploring as these individuals

629   commonly hold high-ranking positions within a group (Lee & Cowlishaw, 2017).

630   *Is Participation Determined By Neophobia?*

631   In two models, we found that neophobic individuals had longer latencies to contact the paper

632   bags compared to less neophobic conspecifics. This effect, however, was inconsistent, as it

633   was not found to be a determinant of the exploration given to the paper bags, nor was it

634   present in any of the analyses concerning the blue cardboard square. Consequently, we are

635   cautious in interpreting this as evidence of a neophobic response; rather, we think the likely

636   explanation is that the variables we analysed here represent motivational, rather than

637   neophobic responses.

638   It is possible that the latency observed in the experiments arises in response neither

639   to motivation nor novelty, but rather reflects other factors. For instance, individuals could

640   have been more or less likely to contact either stimuli in response to acute or chronic

641   stressors. Accurately measuring and/or distinguishing the effect of both before or during

642   testing is generally challenging however, as experimenters may only be able to use

643   behavioural observations to quantify stress responses (e.g. self-directed behaviours: Castles

644   et al., 1999). Similarly, animals may intentionally delay approaching a novel stimulus to

645   avoid attracting the attention of conspecifics (Beauchamp, 2006) and either lose the reward,

646   or risk being recipients of aggression. Unfortunately, these effects are difficult to differentiate

647   from one another, a common problem for studies evaluating cognitive performance. It is

648   additionally difficult to estimate the effect the presence of a human experimenter has on

649 animals' participation. Numerous studies detail the influence human experimenters have on

650 cognitive performance (e.g. *P. troglodytes*: Call et al., 1998; *Pongo* spp: Damerius et al.,

651 2017), including contact with tasks (New Caledonian crow, *Corvus moneduloides*: Kenward

652 et al., 2006). It is likely wild animals have a more fearful response to human observers than

653 their captive conspecifics (e.g. Cowlishaw, 2010), which makes them less prone to participate

654 in novel tasks.

655 Our evaluation of individual differences in participation highlights two important

656 findings. First, we found that participation in cognitive evaluations in wild conditions are

657 likely not representative of the population. Second, we found that both, individual traits and

658 short-term external factors like the availability of alternative activities and the propensity to

659 use social information could partly explain this bias. The positive trend in rates of

660 participation between the two tests is consistent with our findings that juveniles were more

661 likely to interact with and explore both the coloured paper bags and blue cardboard square,

662 and highlights the importance of considering individual identity in cognitive evaluations.

663 Although we aimed to account for any bias by having a representative sample, we were

664 constrained by certain aspects of baboon behaviour and the short-term challenges of testing

665 free-living individuals in achieving this. Presenting the stimuli opportunistically meant that

666 distractions were, at times, unavoidable and other factors such as the distance to the stimuli

667 could not be standardized.

668 We stress the necessity of thoroughly reporting the number of participants in

669 cognitive evaluations and, when possible, providing a breakdown of the different samples

670 that contacted, explored, and/or completed the task. Similarly, all relevant sources of bias

671 should be accounted for and/or properly discussed (e.g. STRANGE: Webster & Rutz, 2020),

672   as this will determine how performance and cognitive abilities in general, are interpreted and

673   whether they can be generalised across the general population.

674   **CONCLUSION**

675   Our evaluation of participation in two tasks of free-living baboons indicate that bias in

676   participation was determined by an individuals' age class, the availability of competing

677   activities and individuals' information use propensities. Juveniles had shorter latencies to

678   contact both types of stimuli and longer exploratory times of both, while the opposite was

679   true when individuals where involved in consummatory activities at the time of testing. A

680   higher propensity to scrounge in juveniles and females resulted in shorter latencies to contact

681   the paper bag stimuli, but no such relationship was observed with regards to the exploration

682   of the blue cardboard square stimulus. Our findings emphasise the bias inherent in

683   generalizing findings from the subsets of animals that participate in cognitive testing, and the

684   need to report task participation in cognitive evaluations in both wild and captive conditions.

685

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699 **REFERENCES**

700 Almeling, L., Hammerschmidt, K., Sennhenn-Reulen, H., Freund, A. M., & Fischer, J.
701 (2016). Motivational shifts in aging monkeys and the origins of social selectivity.
702 *Current Biology*, *26*, 1744–1749. https://doi.org/10.1016/j.cub.2016.04.066

703 Altmann, S. A. (1974). Baboons, space, time, and energy. *American Zoologist*, *14*, 221–248.
704 https://doi.org/10.1093/icb/14.1.221

705 Amici, F., Caicoya, A. L., Majolo, B., & Widdig, A. (2020). Innovation in wild Barbary
706 macaques (*Macaca sylvanus*). *Scientific Reports*, *10*, 1–12.
707 https://doi.org/10.1038/s41598-020-61558-2

708 Aplin, L. M., & Morand-Ferron, J. (2017). Stable producer–scrounger dynamics in wild
709 birds: Sociability and learning speed covary with scrounging behaviour. *Proceedings of*
710 *the Royal Society B: Biological Sciences*, *284*, 20162872.
711 https://doi.org/10.1098/rspb.2016.2872

712 Aplin, L. M., Sheldon, B. C., & Morand-Ferron, J. (2013). Milk bottles revisited: Social
713 learning and individual variation in the blue tit, *Cyanistes caeruleus*. *Animal Behaviour*,
714 *85*, 1225–1232. https://doi.org/10.1016/j.anbehav.2013.03.009

715 Ashton, B. J., Ridley, A. R., Edwards, E. K., & Thornton, A. (2018). Cognitive performance
716 is linked to group size and affects fitness in Australian magpies. *Nature*, *554*, 364–367.
717 https://doi.org/10.1038/nature25503

718 Bates, D., Mächler, M., Bolker, B. M., & Walker, S. C. (2015). Fitting linear mixed-effects
719 models using lme4. *Journal of Statistical Software*, *67*, 1–48.
720 https://doi.org/10.18637/jss.v067.i01

721 Beauchamp, G. (2006). Phenotypic correlates of scrounging behavior in zebra finches: Role
722 of foraging efficiency and dominance. *Ethology*, *112*, 873–878.
723 https://doi.org/10.1111/j.1439-0310.2006.01241.x

724 Benson-Amram, S., & Holekamp, K. E. (2012). Innovative problem solving by wild spotted
725 hyenas. *Proceedings. Biological Sciences / The Royal Society*, *279*, 4087–4095.
726 https://doi.org/10.1098/rspb.2012.1450

727 Bergman, T. J., & Kitchen, D. M. (2009). Comparing responses to novel objects in wild

baboons (*Papio ursinus*) and geladas (*Theropithecus gelada*). *Animal Cognition*, *12*, 63–73. https://doi.org/10.1007/s10071-008-0171-2

Biondi, L. M., Bó, M. S., & Vassallo, A. I. (2010). Inter-individual and age differences in exploration, neophobia and problem-solving ability in a Neotropical raptor (*Milvago chimango*). *Animal Cognition*, *13*, 701–710. https://doi.org/10.1007/s10071-010-0319-8

Biro, P. A., & Dingemanse, N. J. (2009). Sampling bias resulting from animal personality. *Trends in Ecology & Evolution*, *24*, 66–67. https://doi.org/10.1016/j.tree.2008.11.001

Boogert, N. J., Madden, J. R., Morand-Ferron, J., & Thornton, A. (2018). Measuring and understanding individual differences in cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*, 20170280. https://doi.org/10.1098/rstb.2017.0280

Boogert, N. J., Reader, S. M., & Laland, K. N. (2006). The relation between social rank, neophobia and individual learning in starlings. *Animal Behaviour*, *72*, 1229–1239. https://doi.org/10.1016/j.anbehav.2006.02.021

Boose, K. J., White, F. J., & Meinelt, A. (2013). Sex differences in tool use acquisition in bonobos (*Pan paniscus*). *American Journal of Primatology*, *75*, 917–926. https://doi.org/10.1002/ajp.22155

Call, J., Hare, B. A., & Tomasello, M. (1998). Chimpanzee gaze following in an object-choice task. *Animal Cognition*, *1*, 89–99. https://doi.org/10.1007/s100710050013

Carazo, P., Noble, D. W. A., Chandrasoma, D., & Whiting, M. J. (2014). Sex and boldness explain individual differences in spatial learning in a lizard. *Proceedings of the Royal Society B: Biological Sciences*, *281*. https://doi.org/10.1098/rspb.2013.3275

Carter, A.J., Lee, A. E. G., Marshall, H. H., Tico, M. T., & Cowlishaw, G. (2015). Phenotypic assortment in wild primate networks: Implications for the dissemination of information. *Royal Society Open Science*, *2*, 140444. https://doi.org/10.1098/rsos.140444

Carter, Alecia J., Heinsohn, R., Goldizen, A. W., & Biro, P. A. (2012). Boldness, trappability and sampling bias in wild lizards. *Animal Behaviour*, *83*, 1051–1058. https://doi.org/10.1016/j.anbehav.2012.01.033

Carter, Alecia J., Marshall, H. H., Heinsohn, R., & Cowlishaw, G. (2012). How not to measure boldness: Novel object and antipredator responses are not the same in wild baboons. *Animal Behaviour*, *84*, 603–609. https://doi.org/10.1016/j.anbehav.2012.06.015

Carter, Alecia J., Marshall, H. H., Heinsohn, R., & Cowlishaw, G. (2014). Personality predicts the propensity for social learning in a wild primate. *PeerJ*, *2*, e283. https://doi.org/10.7717/peerj.283

Carter, Alecia J., Ticó, M. T., & Cowlishaw, G. (2016). Sequential phenotypic constraints on social information use in wild baboons. *ELife*, *5*, 1–21. https://doi.org/10.7554/eLife.13125

767 Castles, D., Whiten, A., & Aureli, F. (1999). Social anxiety, relationships and self-directed
768   behaviour among wild female olive baboons. *Animal Behaviour*, *58*, 1207–1215.
769   https://doi.org/10.1006/anbe.1999.1250

770 Cauchoix, M., Hermer, E., Chaine, A. S., & Morand-Ferron, J. (2017). Cognition in the field:
771   Comparison of reversal learning performance in captive and wild passerines. *Scientific*
772   *Reports*, *7*, 1–10. https://doi.org/10.1038/s41598-017-13179-5

773 Cole, E. F., Cram, D. L., & Quinn, J. L. (2011). Individual variation in spontaneous problem-
774   solving performance among wild great tits. *Animal Behaviour*, *81*, 491–498.
775   https://doi.org/10.1016/j.anbehav.2010.11.025

776 Cowlishaw, G. (2010). Alarm calling and implications for risk perception in a desert baboon
777   population. *Ethology*, *103*, 384–394. https://doi.org/10.1111/j.1439-
778   0310.1997.tb00154.x

779 Cronin, K. a, Pieper, B. a, van Leeuwen, E. J. C., Mundry, R., & Haun, D. B. M. (2014).
780   Problem solving in the presence of others: How rank and relationship quality impact
781   resource acquisition in chimpanzees (*Pan troglodytes*). *PloS One*, *9*, e93204.
782   https://doi.org/10.1371/journal.pone.0093204

783 Damerius, L. A., Forss, S. I. F., Kosonen, Z. K., Willems, E. P., Burkart, J. M., Call, J.,
784   Galdikas, B.M.F., Liebal, K., Haun, D.BM., Van Schaik, C. P. (2017). Orientation
785   toward humans predicts cognitive performance in orang-utans. *Scientific Reports*, *7*,
786   40052. https://doi.org/10.1038/srep40052

787 Dean, L. G., Hoppitt, W., Laland, K. N., & Kendal, R. L. (2011). Sex ratio affects sex-specific
788   innovation and learning in captive ruffed lemurs (*Varecia variegata* and *Varecia rubra*).
789   *American Journal of Primatology*, *73*, 1210–1221. https://doi.org/10.1002/ajp.20991

790 Desrochers, A. (1992). Age and foraging success in European blackbirds: Variation between
791   and with individuals. *Animal Behaviour*, *43*, 885–894. https://doi.org/10.1016/S0003-
792   3472(06)80002-3

793 Fagot, J., & Bonté, E. (2010). Automated testing of cognitive performance in monkeys: Use
794   of a battery of computerized test systems by a troop of semi-free-ranging baboons
795   (*Papio papio*). *Behavior Research Methods*, *42*, 507–516.
796   https://doi.org/10.3758/BRM.42.2.507

797 Fagot, J., & Paleressompoulle, D. (2009). Automatic testing of cognitive performance in
798   baboons maintained in social groups. *Behavior Research Methods*, *41*, 396–404.
799   https://doi.org/10.3758/BRM.41.2.396

800 Forss, S. I. F., Schuppli, C., Haiden, D., Zweifel, N., & van Schaik, C. P. (2015). Contrasting
801   responses to novelty by wild and captive orangutans. *American Journal of Primatology*,
802   *77*, 1109–1121. https://doi.org/10.1002/ajp.22445

803 Franks, V. R., & Thorogood, R. (2018). Older and wiser? Age differences in foraging and
804   learning by an endangered passerine. *Behavioural Processes*, *148*, 1–9.
805   https://doi.org/10.1016/j.beproc.2017.12.009

806 Gajdon, G. K., Fijn, N., & Huber, L. (2004). Testing social learning in a wild mountain parrot,

the kea (*Nestor notabilis*). *Learning & Behavior : A Psychonomic Society Publication*, *32*(1), 62–71. https://doi.org/10.3758/BF03196007

Giraldeau, L.-A., & Caraco, T. (2000). *Social Foraging Theory*. Princeton, U.S: Princeton University Press.

Giraldeau, L.-A., & Lefebvre, L. (1986). Exchangeable producer and scrounger roles in a captive flock of feral pigeons: A case for the skill pool effect. *Animal Behaviour*, *34*, 797–803. https://doi.org/10.1016/S0003-3472(86)80064-1

Greenberg, R. (2003). The role of neophobia and neophilia in the development of innovative behaviour of birds. In *Animal Innovation* (pp. 175–196). https://doi.org/10.1093/acprof:oso/9780198526223.003.0008

Huber, L., & Gajdon, G. K. (2006). Technical intelligence in animals: The kea model. *Animal Cognition*, *9*, 295–305. https://doi.org/10.1007/s10071-006-0033-8

Isden, J., Panayi, C., Dingle, C., & Madden, J. (2013). Performance in cognitive and problem-solving tasks in male spotted bowerbirds does not correlate with mating success. *Animal Behaviour*, *86*, 829–838. https://doi.org/10.1016/j.anbehav.2013.07.024

Jahn-Eimermacher, A., Lasarzik, I., & Raber, J. (2011). Statistical analysis outcomes in behavioral experiments. *Behavioural Brain Research*, *221*, 271–275. https://doi.org/10.1016/j.bbr.2011.03.007.Statistical

Johnson-Ulrich, L., Johnson-Ulrich, Z., & Holekamp, K. (2018). Proactive behavior, but not inhibitory control, predicts repeated innovation by spotted hyenas tested with a multi-access box. *Animal Cognition*, *21*(3), 379–392. https://doi.org/10.1007/s10071-018-1174-2

Johnson, S. E., & Bock, J. (2004). Trade-offs in skillacquisition and time allocation among juvenile chacma baboons. *Human Nature*, *15*, 45–62. https://doi.org/10.1007/s12110-004-1003-y

Katsnelson, E., Motro, U., Feldman, M. W., & Lotem, A. (2011). Individual-learning ability predicts social-foraging strategy in house sparrows. *Proceedings of the Royal Society B: Biological Sciences*, *278*, 582–589. https://doi.org/10.1098/rspb.2010.1151

Kendal, R. L., Coe, R. L., & Laland, K. N. (2005). Age differences in neophilia, exploration, and innovation in family groups of callitrichid monkeys. *American Journal of Primatology*, *66*, 167–188. https://doi.org/10.1002/ajp.20136

Kenward, B., Rutz, C., Weir, A. a. S., & Kacelnik, A. (2006). Development of tool use in New Caledonian crows: Inherited action patterns and social influences. *Animal Behaviour*, *72*, 1329–1343. https://doi.org/10.1016/j.anbehav.2006.04.007

Krasheninnikova, A., & Schneider, J. M. (2014). Testing problem-solving capacities: Differences between individual testing and social group setting. *Animal Cognition*, *17*, 1227–1232. https://doi.org/10.1007/s10071-014-0744-1

Laidre, M. E. (2008). Spontaneous performance of wild baboons on three novel food-access puzzles. *Animal Cognition*, *11*, 223–230. https://doi.org/10.1007/s10071-007-0104-5

846   Laland, K. N., & Reader, S. M. (1999). Foraging innovation in the guppy. *Animal Behaviour*,
847   *57*, 331–340. https://doi.org/10.1006/anbe.1998.0967

848   Lee, A. E. G., & Cowlishaw, G. (2017). Switching spatial scale reveals dominance-dependent
849   social foraging tactics in a wild primate. *PeerJ*, *5*, e3462.
850   https://doi.org/10.7717/peerj.3462

851   Lee, A. E. G., Ounsley, J. P., Coulson, T., Rowcliffe, J. M., & Cowlishaw, G. (2016).
852   Information use and resource competition: An integrative framework. *Proceedings of*
853   *the Royal Society B: Biological Sciences*, *283*, 20152550.
854   https://doi.org/10.1098/rspb.2015.2550

855   Marshall, H. H., Carter, A. J., Coulson, T., Rowcliffe, J. M., & Cowlishaw, G. (2012).
856   Exploring foraging decisions in a social primate using discrete-choice models. *The*
857   *American Naturalist*, *180*, 481–495. https://doi.org/10.1086/667587

858   Millidine, K. J., Armstrong, J. D., & Metcalfe, N. B. (2006). Presence of shelter reduces
859   maintenance metabolism of juvenile salmon. *Functional Ecology*, *20*, 839–845.
860   https://doi.org/10.1111/j.1365-2435.2006.01166.x

861   Mirville, M. O., Kelley, J. L., & Ridley, A. R. (2016). Group size and associative learning in
862   the Australian magpie (*Cracticus tibicen dorsalis*). *Behavioral Ecology and*
863   *Sociobiology*, *70*, 417–427. https://doi.org/10.1007/s00265-016-2062-x

864   Morand-Ferron, J., Hamblin, S., Cole, E. F., Aplin, L. M., & Quinn, J. L. (2015). Taking the
865   operant paradigm into the field: Associative learning in wild great tits. *PLoS ONE*, *10*,
866   1–16. https://doi.org/10.1371/journal.pone.0133821

867   Morand-Ferron, J., Wu, G. M., & Giraldeau, L. A. (2011). Persistent individual differences
868   in tactic use in a producer-scrounger game are group dependent. *Animal Behaviour*, *82*,
869   811–816. https://doi.org/10.1016/j.anbehav.2011.07.014

870   Morton, F. B., Lee, P. C., & Buchanan-Smith, H. M. (2013). Taking personality selection
871   bias seriously in animal cognition research: A case study in capuchin monkeys (*Sapajus*
872   *apella*). *Animal Cognition*, *16*, 677–684. https://doi.org/10.1007/s10071-013-0603-5

873   Patterson, E. M., Krzyszczyk, E., & Mann, J. (2016). Age-specific foraging performance and
874   reproduction in tool-using wild bottlenose dolphins. *Behavioral Ecology*, *27*, 401–410.
875   https://doi.org/10.1093/beheco/arv164

876   Pritchard, D. J., Hurly, T. A., Tello-Ramos, M. C., & Healy, S. D. (2016). Why study
877   cognition in the wild (and how to test it)? *Journal of the Experimental Analysis of*
878   *Behavior*, *105*, 41–55. https://doi.org/10.1002/jeab.195

879   Reader, S. M., & Laland, K. N. (2001). Primate innovation: Sex, age and social rank
880   differences. *International Journal of Primatology*, *22*(5), 787–805.
881   https://doi.org/10.1023/A:1012069500899

882   Rolls, E. T. (2005). *Emotions Explained*. Oxford, U.K: Oxford University Press.
883   https://doi.org/10.1093/acprof:oso/9780198570035.001.0001

884   Rowe, C., & Healy, S. D. (2014). Measuring variation in cognition. *Behavioral Ecology*, *25*,

885   1287–1292. https://doi.org/10.1093/beheco/aru090

886 Sol, D., Griffin, A. S., & Bartomeus, I. (2012). Consumer and motor innovation in the
887   common myna: The role of motivation and emotional responses. *Animal Behaviour*, *83*,
888   179–188. https://doi.org/10.1016/j.anbehav.2011.10.024

889 Therneau, T. M., & Lumley, T. (2014). *Package "survival". Survival Analysis. R package*
890   *version   2.37-7.*   Retrieved   from   https://cran.r-
891   project.org/web/packages/survival/index.html

892 Thornton, A., & Lukas, D. (2012). Individual variation in cognitive performance:
893   developmental and evolutionary perspectives. *Philosophical Transactions of the Royal*
894   *Society of London. Series B, Biological Sciences*, *367*, 2773–2783.
895   https://doi.org/10.1098/rstb.2012.0214

896 Thornton, A., & Samson, J. (2012). Innovative problem solving in wild meerkats. *Animal*
897   *Behaviour*, *83*, 1459–1468. https://doi.org/10.1016/j.anbehav.2012.03.018

898 Titulaer, M., van Oers, K., & Naguib, M. (2012). Personality affects learning performance in
899   difficult tasks in a sex-dependent way. *Animal Behaviour*, *83*, 723–730.
900   https://doi.org/10.1016/j.anbehav.2011.12.020

901 van de Waal, E., Renevey, N., Favre, C. M., & Bshary, R. (2010). Selective attention to
902   philopatric models causes directed social learning in wild vervet monkeys. *Proceedings*
903   *of the Royal Society B: Biological Sciences*, *277*, 2105–2111.
904   https://doi.org/10.1098/rspb.2009.2260

905 van Horik, J. O., Langley, E. J. G., Whiteside, M. A., & Madden, J. R. (2017). Differential
906   participation in cognitive tests is driven by personality, sex, body condition and
907   experience.   *Behavioural*   *Processes*,   *134*,   22–30.
908   https://doi.org/10.1016/j.beproc.2016.07.001

909 van Horik, J. O., & Madden, J. R. (2016). A problem with problem solving: Motivational
910   traits, but not cognition, predict success on novel operant foraging tasks. *Animal*
911   *Behaviour*, *114*, 189–198. https://doi.org/10.1016/j.anbehav.2016.02.006

912 Vonk, J., & Povinelly, D. (2011). Individual differences in long-term cognitive testing in a
913   group of captive chimpanzees. *International Journal of Comparative Psychology*, *24*,
914   137–167. https://doi.org/10.5811/westjem.2013.7.18472

915 Webster, M. M., & Rutz, C. (2020). How STRANGE are your study animals? *Nature*, *582*,
916   337–340. https://doi.org/10.1038/d41586-020-01751-5

917

Appendix 1. Summary of individuals tested with each task.

Stimulus	Number of trials	High rank				Middle rank				Low rank				Total
		Males		Females		Males		Females		Males		Females		
		A	Jv	A	Jv	A	Jv	A	Jv	A	Jv	A	Jv	
Paper Bags	111 trials; $\bar{x}$: 3	5/10(50)	5/9 (55)	3/6(50)	0*	0*	7/15 (47)	5/8(63)	1/1(100)	0*	2/7(30)	7/13(53)	2/5(50)	37/86(43)
Blue square	243 trials; $\bar{x}$: 6	5/12(41)	6/9 (67)	0**	0*	0*	1/8(12.5)	8/11(73)	0**	0*	1/2(50)	5/12(42)	1/2(50)	27/67(40)

Shown are: (i) the stimulus presented in each task; (ii) the number of trials per experiment and mean number of trials per individual ($\bar{x}$); and (iii) and the demographic data of the total sample tested (number of individuals tested/number of total individuals in that class) according to dominance rank (High rank, Middle rank and Low rank), sex (Males, Females) and age (A, adults; Jv, juveniles). Dominance ranks were grouped evenly into categories according to tertiles. In parentheses, the percentage (%) of the population the study sample represents. Zero, followed by one asterisk (0*) represents cases where there were no individuals of that specific demographic to test. Zero, followed by two asterisks (0**) represents cases where individuals from that specific demographic were available, but not possible to test.

925 **Appendix 2.** Detailed description of an associative learning task conducted in July-

926 September 2015 and a second-order conditioning task conducted July-September 2016.

927 *Associative Learning Task*

928 Two opaque paper bags were presented on three occasions to foraging individuals. One bag

929 contained approx. 20 corn kernels and, to avoid individuals from assessing presence of food

930 based on the weights/volumes of the bags, the other bag contained approx. 20 small corn

931 kernel-sized pebbles. Each bag was painted in either red or green with non-toxic children's

932 paints, with the pebbles being associated with the incorrect colour cue and the kernels with

933 the correct colour cue. Individuals received a total of three "test" trials, each separated by

934 intervals of three days, such that they were tested on days 0, 3 and 6 (where day 0 was the

935 first presentation). No individual was tested fewer than three times. All trials were conducted

936 between sunrise (0620-0647 h during the testing period) and 1000 h (mean testing time: 0737

937 h) to control for satiation, as individuals are more likely to have similar levels of hunger

938 earlier in the day.

939 *Second-Order Conditioning Task*

940 Study subjects were allocated randomly into three groups, according to whether or not the

941 stimuli were presented together (paired) or separately (unpaired) in Phases I and II of each

942 trial: (1) Paired-Paired (P-P); (2) Paired-Unpaired (P-U); and (3) Unpaired-Paired (U-P). The

943 P-P group was considered the experimental group (since they were given the opportunity to

944 learn the associations between both the US and CS1, and the CS1 and CS2, before being

945 tested to make the association between the US and CS2). This group consisted exclusively

946 of individuals who had previously been presented the paper bags. The P-U and U-P groups

947 were controls (since they were only allowed to learn either the association between the US

948 and CS1, or the CS1 and CS2, before being tested to make the US and CS2 association). Each

949 individual completed one trial, comprising three phases, over the course of a single day. Each

950 phase involved three presentations over a three-hour period, such that each trial lasted nine

951 hours in total. All experiments were conducted by C.M.

952 **Phase I.** Phase I was a simple first-order conditioning task, where individuals were presented

953 with both stimuli three times over three hours at hourly intervals. For the P-P and P-U groups,

954 I paired a small pile of corn kernels (US) with a clicker trainer (CS1) (Beaphar, Suffolk, UK).

955 The clicker was pressed until all the corn was consumed (approx. 20 kernels). Trials in this

956 phase began approx. at 0700 h for all individuals. If a trial was interrupted by the approach

957 of any other animal, the clicking immediately stopped. In this phase, the U-P group

958 experienced unpaired presentations, where the clicker was presented 10 min before or after

959 the corn (and pressed for 10 s) in an alternating order.

Phase II. This phase began one hour after Phase I ended. For the P-P and U-P groups, I

paired the clicker (CS1) with a neutral stimulus, a blue 17 x 17 cm cardboard square (CS2).

This pair was presented three times over three hours. The P-U group experienced unpaired

presentations, where the clicker was presented 10 min before or after the square in an

alternating order.

Phase III. This phase began one hour after Phase II ended. All baboons in all groups were

presented with only the blue cardboard square (CS2). The square was presented three times

over three consecutive hours.

969   **Appendix 3.** Ethogram of chacma baboon behaviours. Shown are the behaviours recorded in the

970   focal follows carried out during the 2015 and 2016 field seasons. Below is a description of each

971   behaviour classified as either: general activities; aggressive behaviours; affiliative behaviours;

972   and self-directed behaviours.

General Activities	1. **Travel:** An individual moves from one location to another. 2. **Resting:** An individual ceases any physical activity (i.e. travelling, foraging) and instead sits or lies down. 3. **Drinking:** An individual lowers its body and drinks from a body of water. 4. **Foraging:** An individual continuously searches for a food itemand once found, it consumes it. 5. **Playing:** An individual socially interacts with conspecifics, commonly of the same age group, in a playful manner.
Aggressive Behaviours	1. **Displacement:** A retreat/approach interaction in which an individual intentionally or unintentionally (i.e. the aggressor does not move directly towards the aggresse).moves or causes a conspecific to move away immediately or after a small delay (~5 s) from a resource. 2. **Supplant:** A retreat/approach interaction in which an individual intentionally or unintentionally (i.e. the aggressor does not move directly towards the aggresse) leaves or takes over a resource (food, shade or grooming partner) immediately or after a small delay (~5 s). 3. **Attack:** An individual bites, pushes, fights or pulls another intentionally. 4. **Threat:** An individual hits (in a sweeping motion) the ground repeatedly and towards the recipient. 5. **Chase:** One or several individuals (in support) run after the recipient. 6. **Chase up a tree:** One or several individuals (in support) run after the recipient forcing it to climb a tree.
Affiliative Behaviours	1. **Grooming:** The individual spreads the hair of a conspecific, pulling out with its hands or mouth.
Self-Directed Behaviours	1. **Self-Scratching:** An individual scratches itself repeatedly and with short fast movements. 2. **Self-Grooming:** An individual grooms itself. 3. **Self-touching:** An individual will touch itself very quickly.

973

974

975   **Appendix 4.** List of plants considered for the Patch Occupation protocol. The habitats the

976   Tsaobis baboons commonly forage in, riparian woodlands and hills, are defined by a number

977   of food patches that consist of tree, herb or bush species, which serve as their main food

978   source. Shown are the tree, herb and shrub species (in *italics*) recorded during focal follows.

979

Trees	*Faidherbia albida*
	Prosopis glandulosa
	Tapinanthus oleifolius
	Acacia tortilis
	Acacia erioloba
	Ficus sycomorus
Herb/Shrubs	*Salvadora persica*
	Monechma cleomoides
	Nicotiana glauca
	Sesamum capense
	Commiphora virgata

987 **Supplementary Material S1.** Spearman rank correlation coefficients, *S*, of the predictor

988 variables used in the analyses evaluating the likelihood/latency to contact and exploration of

989 two types of stimuli: a set of paper bags and a blue cardboard square. (A): n = 104 for

990 activity/108 for distance to stimuli; n = 111 for the rest; (B): n = 156 for activity; n = 162 for

991 the rest.

992   **(A)** Paper Bags

	Sex	Age	S. Rank	Neophobia	Activity	Info. Use	Distance	Interruption
Sex	1.00							
Age	0.57	1.00						
Social Rank	0.58	0.03	1.00					
Neophobia	0.10	0.51	-0.22	1.00				
Activity	-0.17	-0.12	-0.07	-0.08	1.00			
Information Use	-0.04	-0.15	0.24	-0.27	-0.14	1.00		
Distance to stimulus	-0.02	-0.13	0.22	-0.15	0.29	-0.02	1.00	
Interruption	-0.18	0.01	-0.25	0.01	-0.08	0.08	-0.06	1.00

993

994   **(B)** Blue cardboard square

	Sex	Age	S. Rank	Neophobia	Activity	Info. Use	Distance	Interruption
Sex	1.00							
Age	0.64	1.00						
Social Rank	0.73	0.27	1.00					
Neophobia	0.12	0.36	0.11	1.00				
Activity	-0.02	-0.02	-0.03	0.10	1.00			
Information Use	0.05	0.19	-0.15	-0.09	0.04	1.00		
Distance to Stimuli	0.11	0.03	0.19	-0.09	-0.03	-0.06	1.00	
Interruption	-0.01	0.05	0.02	0.01	-0.09	-0.04	0.16	1.00

995