Is painting by elephants in zoos as enriching as we are led to believe?

The relationship between the activity of painting and performance of stereotyped and other stress-related behaviour was investigated in four captive Asian elephants at Melbourne Zoo, Australia. The activity involved the elephant being instructed to paint on a canvas by its keeper in front of an audience. Painting by elephants in zoos is commonly believed to be a form of enrichment, but this assumption had not been based on any systematic research. If an activity is enriching we would expect stress-related behaviour to be reduced but we found no evidence of the elephants anticipating the painting activity and no effect on the performance of stereotyped or other stress-related behaviour either before or after the painting session. This indicates that the activity does not fulfil one of the main aims of enrichment. However, if an elephant was not selected to paint on a given day this was associated with higher levels of non-interactive behaviour, a possible indicator of stress. Behavioural observations associated with ear, eye and trunk positions during the painting session showed that the elephant's attentiveness to the painting activity or to the keeper giving instruction varied between individuals. Apart from positive reinforcement from the keeper, the results indicated that elephants gain little enrichment from the activity of painting. Hence, the benefits of this activity appear to be limited to the aesthetic appeal of these paintings to the people viewing them.

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Introduction

Since the 1960's elephants have been considered intelligent (Rensch, 1957; Gordon, 1966), with

significant research about their cognitive abilities taking place in recent years (Shoshani, Kupsky

& Marchant, 2006; Bradshaw & Schore, 2007; Hart, Hart & Pinter-Wollman, 2008; Byrne, Bates

& Moss, 2009). It is now clear that elephants can solve problems (Foerder et al., 2011), use tools

(Chevalier-Skolnikoff & Liska, 1993; Hart & Hart, 1994; Hart et al., 2001) have empathy (Bates,

2008; Byrne et al., 2008), recognise human faces (McComb et al., 2014), show the complex

behaviour of self-recognition (Plotnik, de Waal & Reiss, 2006; Plotnik et al. 2010, 2011) and

have a high level of social complexity (Poole, 1996; Schulte, 2000; Payne, 2003; Wittemyer et

al., 2005). It is therefore a reasonable assumption that elephants may be able to learn to paint and

they certainly would have no difficulty in using the trunk to direct a paint brush.

Evidence of their complex communication (Poole et al., 1988; Langbauer, 2000) in stable

social relationships (Moss & Poole, 1983; Nair et al., 2009) and their phenomenal memories

(Moss, 1988), particularly of spaces and resources, has been demonstrated repeatedly. Questions

have been raised how such animals, that are self-aware and remember their own past, are affected

by captivity and by traumatic events in the wild (Bradshaw et al., 2005; Machowski et al., 2013).

Indeed, animals now known to be as complex in their comprehension of their surroundings raise

additional questions on how to avoid boredom and stress by confinement. While such

establishments as zoos and sanctuaries are expected to provide each species with enrichment

adequate to enhance species-specific psychological and physiological wellbeing (Hediger, 1950;

Carlstead & Shepherdson, 2000; Mellen & MacPhee, 2005; Veasey, 2006), it is clear that

elephants present very challenging problems. They are large in size, and space in zoos may be too

73   limited to be adequate. Their natural feeding habits usually occupy much of the day (and in large

74   quantities) and their browsing habits in the wild usually make them cover large distances

75   (Samansiri & Weerakoon, 2007). Adequate compensations for such habits and skills pose almost

76   insurmountable problems and it as clear to many that such enrichment ought to be more varied

77   and complex than just hiding food (Lair 1997, Wiedenmayer 1998). Occupying them in some

78   games or varied routines is certainly a strategy that many zoos have adopted. One of the activities

79   assumed to provide enrichment to captive elephants is allowing them to paint on canvas using

80   coloured paints and brushes under the guidance of zoo keepers (Gilbert, 1990; Tennesen 1998;

81   Rogers & Kaplan, 2007).

82   According to Forthman & Ogden (1992), a reduction in stress can be realized by creating

83   interesting environments and activities that encourage natural behaviour; for example, by

84   providing animals with opportunities to solve problems, to make choices and to obtain a sense of

85   control over their environment. Enrichment strategies vary widely according to species, staff

86   availability and the ingenuity of their keepers. With a few exceptions (and elephant management

87   is one of them; Sevenich et al. 1998; Shepherdson 1999; Stoinski et al. 2000) it has rarely been

88   tested in a rigorous fashion as to whether these measures purported to be beneficial actually are.

89   Many enrichment programs, sometimes of necessity, are highly contrived and find no equivalent

90   in a species' natural environment. Whether contrived or not, in such cases one might argue that

91   the end justifies the means if it can be shown that there is a measurable benefit to reduce stress

92   and abnormal behaviour, often a consequence of prolonged stress. The question is whether the

93   activity of painting is an activity that might be enjoyable for elephants? While highly imaginative

94   as an idea, of course, as far as we know anything equating painting does not occur in the wild,

95   although the trunk has been shown to be used for many purposes (Shoshani, 1997).

96   In order to establish whether painting benefits elephants, and is therefore a form of

97 enrichment, some key questions needed to be addressed. Does painting change stress behaviour

98 in any way? If so, is there a difference in stereotyped movements and reduced social interaction

99 on the days when an elephant paints compared to days when it does not? Painting might appeal

100 to the higher cognitive abilities of elephants, as it involves the learnt use of a tool. The tool-using

101 aspect of painting could, therefore, be stimulating to a species that uses tools in the natural

102 environment (Chevalier-Skolnikoff & Liska, 1993; Hart & Hart, 1994; Shoshani, 1997). On the

103 other hand, because the act of painting is not a typical behaviour for elephants it could itself

104 cause stress. A way of assessing stress behaviourally would be to measure stereotyped and

105 abnormal behaviour before, during and after painting, provided any stereotypical or abnormal

106 behaviour had been noted in the elephants to be observed.

107   Captive animals often develop stereotyped behaviours that are rarely observed in wild or

108 free-ranging animals (Boorer, 1972). A stereotypy has been defined as a repetitive, invariant

109 behaviour pattern with no obvious goal or function (Odberg, 1987; Mason, 1991). Mason &

110 Latham (2004) found that situations in which stereotyped behaviour occurs are usually a sign of

111 poor welfare conditions. However, those individuals performing the stereotyped behaviour,

112 which may be related to an earlier experience of a stressful situation (Schmid et al., 2001), often

113 have lower levels of stress hormones (e.g. cortisol) than those not performing stereotyped

114 behaviour (Mason & Latham, 2004). There is ample evidence that anticipation of being fed

115 (Friend, 1999; Rees, 2004) or of other events important to a captive elephant (Friend; 1999; Kurt

116 & Garai, 2002) may induce stereotypies which occur because arousal levels increase and the

117 animal is unable to do anything but wait until the anticipated activity takes place (Elzanowski &

118 Sergiel, 2006). It has also been found that low temperature can trigger an increase in stereotypic

119 behaviour if the elephants in question have had a traumatic past (Rees, 2004) suggesting that

120 seemingly unrelated events can alter the expression of distress quite rapidly in elephants.

121   Elephants display a number of typical stereotyped patterns of behaviour. Weaving

122 behaviour performed by both Asian and African elephants in captivity consists of swaying the

123 head from side to side while transferring the weight from one foreleg to another, and swinging

124 the trunk at the same time. Head bobbing consists of repeated up and down or forward and

125 backward rocking of the head while standing still, and pacing in their enclosures (Kiley-

126 Worthington, 1990; Langbauer, 2000; Rees, 2004). We were interested in measuring whether the

127 prevalence and intensity of these stereotypies and other stress related behaviour varied before and

128 after painting sessions.

129   Natural body postures in elephants have also been described in great detail and have been

130 known for a long time, indicating that the position of ears, movements and activities of the trunk

131 and the tail may have very specific meanings (Kuhme, 1963; McKay, 1973) and are useful

132 devices for scoring details of an elephant's state of mind and mood.

133

134 **METHODS**

135 **Focal species and enclosures**

136 This study was conducted between October 2007 to February 2008, observing four female

137 elephants housed at Melbourne Zoo. Ethics approval was given by the Animal Ethics Committee

138 at the University of New England (AEC07/096). All four elephants were of Asian origin

139 (*Elephas maximus*); three from Thailand (*Elephas maximus indicus*) (hereafter referred to as

140 elephants A, B and C) and one Malaysian (*Elephas maximus sumatranus*) (hereafter referred to as

141 elephant D). Each elephant had different levels of experience in painting: A (7 years old), B (10

142 years old) and C (15 years old) had been painting for 2-3 years and D (33 years old) had been

143 painting for approximately 8 years. At the onset of this study, A, B and C had been at Melbourne

144 Zoo for one year and D for 30 years.

145   The elephants in this study did not constitute a selected sample but represented the entire

146 cohort of participants in painting sessions at Melbourne Zoo at the time; i.e. every elephant was

147 scored that was involved in painting during the study period. The only male housed at Melbourne

148 was at that time not trained in performing painting and was therefore not involved in this study.

149 Which elephants were to perform painting on a given day was decided by the keeper minutes

150 before the elephants were to be moved to the painting enclosure and the choice was based on

151 general demeanour.

152   The building in which painting took place, also used for medical checks, treatment

153 administration, washing, feeding, and obedience task training, contained four stalls: the stalls in

154 which painting took place were 6m x 6m. The elephants were always taken into the building for

155 the painting session in the same pairs (either A/B or C/D), and then separated into different stalls

156 for the painting session. One elephant was given food while the other painted. Each painting

157 session lasted less than 5 minutes.

158 ***Behavioural data collection***

159 Daily behavioural scoring took place at three intervals: from 10.00am to 11.00am (3-4 hours

160 before the painting session), from 1.00pm to 2.00pm (1 hour before the painting session) and

161 from 4.00pm to 5.00pm (1 hour after the painting session). This occurred twice per week. A focal

162 subject was selected for scoring, in pseudo-random order, and its behaviour was recorded in all

163 sessions that day regardless of whether it was selected to paint or not. For each elephant, four

164 days were scored in each of the following conditions: (1) days when the focal elephant painted,

165 (2) days when the focal elephant did not paint and other elephants did and (3) days when no

166 painting took place.

167   The behaviour was scored using two techniques: (1) videorecorded, and later replayed to

168 score behaviour, and (2) direct observation within 5-20 m of the focal elephant. Minute-interval

169 sampling was used to record various behaviours that occurred for longer durations (for example

170 social interaction, stereotyped or non-interactive behaviour), and event recording was used for

171 behaviour that occurred infrequently and less often (for example, vocalisations).

172 The following behaviour was scored (see Kuhme, 1963; McKay, 1973; Poole & Granli, 2009):

173 1) **Interactive** behaviour – involving social interactions with conspecifics including visual and

174 tactile displays during affiliation or playful interactions. For example, using the trunk to smell

175 and touch another elephant, ear-flapping, tail-raising without defecation, tail slapping against

176 body or holding ears forward (45°-90° from body).

177 2) **Non-interactive** behaviour was comprised of standing still with the trunk tip touching the

178 ground, ears in neutral position (<45° from body), tail in a neutral position and separate from

179 other elephants. Head is upright and eyes open to differentiate from sleeping.

180 3) **Independent activity** included exploratory behaviour, not involving conspecific interaction,

181 such as using the trunk to smell, touch or manipulate an object, placing the ears forward (45°-90°

182 from body) and raising the tail without defecation.

183 4) **Stereotyped or abnormal behaviour** such as weaving, pacing, head-bobbing, trunk-swinging

184 and other repetitive or abnormal behaviours. These were considered to be stereotyped if they

185 were repeated in quick succession and appeared to serve no function related to their external

186 environment.

187 5) **Waiting** at the door or gate to the indoor enclosure where painting took place. This behaiour

188 reflected anticipation and might indicate if an elephant voluntarily put itself in a position nearer

189 to its keepers and to the area where it would paint.

190 6) **Vocalisations** were scored using event sampling. These included chirps, growls, snorts,

191 trumpets and roars.

Behaviour scored during the painting session

193 Painting involved following instructions from the keeper and performing the task in front of an

194 audience. A canvas was held in front of the elephant at their eye level and at a distance where the

195 elephant could reach it by full or partial extension of the trunk. Either the keepers, or selected

196 members of the public, chose the colour of the paint. The brush was then handed to the elephant,

197 which it then held with its trunk. Instruction was given by the keeper to the elephant when to

198 start and stop painting, and when to give the brush to the keeper for colour changes. Positive

199 reinforcement was usually given throughout the activity in the form of food and verbal

200 encouragement from the keeper.

201 Both elephants in the pair that were taken into the building for painting had their

202 behaviour recorded. Painting sessions took place once a week between 2.30pm and 3.00pm.

203 Each session lasted between 2 and 5 minutes, and was a highly structured event. For example,

204 when the elephant was not holding the paintbrush and awaiting the next instruction it was

205 directed to rest its trunk tip on the ground (elephants C/D) or to raise its trunk and rest the tip on

206 the trunk base (elephants A/B). A total of 16 painting sessions were recorded (four per elephant).

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209   *Behaviour scored during painting session*

210   1) **Ear positions** were recorded to indicate arousal level (Kuhme, 1963; McKay, 1973). The

211   amount of time that the elephant spent with its ears held in particular positions during the

212   painting session was quantified. Positions included, ears forward (45°- 90° from body -indicating

213   a high level of arousal), ears neutral (<45° from body) and ears against the body (commonly a

214   sign of apprehension and submission- Kuhme, 1963). Ear flapping was not recorded due to the

215   difficulty in differentiating whether this was a reaction to the activity or for thermoregulation.

216   2) **Gaze direction** indicated whether the elephant was looking at the painting, the audience or the

217   keeper giving commands. Direction of gaze was determined by recording the eye white position.

218   For example, if the white of the left eye was nasal and/ or the eye white of the right eye was

219   temporal, the elephant was viewing the keeper, who always stood on the elephant's left side.

220   Stereotyped and abnormal behaviour was not recorded during the painting session due the short

221   period of time during which there was very little opportunity for the elephants to behave in any

222   way other than that determined by the keeper's instructions.

223   *Data analyses*

224   Behavioural scores were anlaysed using the SPSS 16.00 statistical programme. Initially, for each

225   behaviour, we compared replicates (four per elephant) at the three different times of day

226   (morning, midday and afternoon) using a repeated measures General Linear Model (where

227   replicates were the repeated measures and time of day the factor). Then condition (P=focal

228   elephant paints, NP=no elephant paints and OP=other elephant, not focal elephant, paints) was

229   tested as the factor and time of day as the repeated measure using the repeated measures GLM

230   test. Behaviour recorded during the painting session was analysed, first using a Kruskal-Wallis

231   non-parametric test for heterogeneity, followed by Mann-Whitney U-tests.

232

RESULTS

Stereotyped and abnormal behaviour

235 Analysis of these scores revealed that there were no main effects of replicates in any of the three

236 conditions (P, NP, OP) ($F_{3,9}$ ranged from 0.529 to 1.341 and P ranged from 0.34 to 0.67). There

237 were no interactions between the time of day and replicates ($F_{6,18}$ ranged from 0.658 to 2.185 and

238 p ranged from 0.09 to 0.68). There was a significant effect of time of day on the frequency of

239 performance of stereotyped and abnormal behaviour but only on the day when the focal elephant

240 was selected to paint ($F_{2,6}$=6.681, p=0.028; Figure 1 a).

241 Since 'replicate' was found to have no significant main effect or interaction with 'time of

242 day', means of the replicates were calculated and used in a further analysis using condition as the

243 repeated measure and time of day as the factor. This analysis revealed that there was a non-

244 significant interaction between condition and time of day ($F_{4,60}$=2.452, p= 0.056). However, the

245 trend towards significance is noted: on the days when the elephants were selected to paint they

246 tended to perform less stereotyped and abnormal behaviour in the morning than on the other days

247 ($F_{2,6}$= 6.861, p=0.028).

248 Figure 1 b) shows the variation between individual elephants for the mean occurrence of

249 stereotyped/abnormal behaviour at three different times of the day. The incidence of stereotyped

250 and abnormal behaviour noted in elephants A and B differed to some extent from that of

251 elephants C and D. Stereotypy and abnormal behaviour were found for days when the elephant

252 was not selected to paint as well as on days when the elephant painted.

253   A repeated measures GLM test comparing the occurrence of stereotyped/abnormal

254   behaviour at different times (morning, midday and afternoon) between elephants for each

255   condition revealed that there was a significant difference between elephants on the days when

256   they were not selected to paint ($F_{6,18}$ = 7.448, p= 0.008). Bonferroni pair-wise comparisons

257   revealed that B and C were significantly different (p= 0.039) whereas A and D tended to be

258   different but it was not significant (p= 0.059).

259   ***Other behaviour***

260   Scores of vocalisations, interactive, non-interactive, independent activity and time spent waiting

261   were analysed separately for the three conditions.   As there were no significant effects of the

262   replicates for any of the types of behaviour and no significant interactions between time of day

263   and replicate, the means of the replicates were calculated and used in further analyses using

264   condition as the repeated measure and time of day as the factor.   The results are presented in

265   Table 1.

266   The only significant results of these analyses were interactions between condition and

267   time for non-interactive behaviour ($F_{4,60}$ = 2.520, p= 0.050) and time spent waiting ($F_{4,60}$= 2.665,

268   p= 0.041). Therefore only these two data sets were examined further.

269   ***Non-interactive Behaviour***

270   A further repeated measures GLM test to analyse the data for non-interactive behaviour revealed

271   a significant interaction between condition and time ($F_{2,6}$ =6.065, p= 0.036). The level of non-

272   interactive behaviour was higher in the afternoon on days when no elephant painted than on days

273   when the focal elephant was selected to paint (p= 0.041; Figure 2 a). The data for non-interactive

274   behaviour were examined further by comparing individual differences between elephants across

275   the three conditions (Figure 2 b). Compared to the other elephants, elephant D displayed much

276 higher levels of non-interactive behaviour on days when no painting took place, especially in the

277 afternoon. This increase from midday to afternoon when no painting took place was shown in all

278 four replications for D.

279   Overall, the results for the periods outside of the painting session show that elephants C

280 and D performed more stereotyped/abnormal behaviour than elephants A and B, particularly on

281 days when they did not paint. D showed more non-interactive behaviour when no painting took

282 place and more waiting at the door to the indoor area where painting occurs when she was not

283 selected to paint than did the other elephants.

284 Behaviour during the painting session

285 During the painting sessions the elephants were given a mean (±sem) of 38±3.49 commands by

286 the keeper. The mean duration of the painting session was 211±41sec.

287

288   Direction of gaze during painting session

289 Elephants A and B, and to a lesser extent C, spent the majority of the session looking at the

290 keeper standing to their left side (Figure 3 a). D looked at the keeper the least often and spent the

291 highest percentage of time looking ahead at the canvas, or the person holding the canvas. A

292 Kruskal-Wallis test revealed a significant difference between elephants for time spent with gaze

293 directed at the keeper (α^2= 9.516, p= 0.023) and gaze directed ahead (α^2=10.304, p= 0.016).

294   Position of ears, head and trunk during painting session

295 Figure 3 b) shows the percentage of time, during the painting session, for which the ears were

296 held in the different positions. Kruskal-Wallis tests revealed that the elephants differed in time

297 spent with their ears forward (α^2=8.824, n=4, p= 0.032) and the ears not forward (α^2=11.138, n=4,

298   p= 0.011). Elephant A differed significantly from elephants B (ears back, U= 2.000, p= 0.046), C

299   (ears forward, U=1.000, p= 0.043, ears not forward, U=.000, p= 0.021) and D (ears forward,

300   U=.000, p= 0.021, ears not forward, U=0.000, p= 0.018, and ears back, U=2.000, p= 0.046). B

301   also differed from D (ears forward, U=1.000, p= 0.043, ears not forward, U=0.000, p= 0.018).

302

303   **DISCUSSION**

304   ***Stereotyped and abnormal behaviour***

305   The scores of stereotyped behaviour tended to be lower in the morning on the day when the

306   elephant painted than on days when no elephants painted. Post hoc enquiries revealed that

307   keepers selected those elephants showing less stereotyped and abnormal behaviour in the

308   morning to paint that day. Hence, our results reflect this practice.

309   By midday (1 hour before painting) the incidents of stereotyped and abnormal behaviour

310   was similar to that performed at midday on the days when no painting took place. Therefore, the

311   increase in stereotyped and abnormal behaviour between morning and midday on the day when

312   the elephant painted may not have been associated with anticipation of the painting session but,

313   instead, indicated a return to levels typical at that time of day. Hence, despite anticipation of

314   certain events (such as feeding and performing), identified as being a major facilitator of

315   stereotyped behaviour in some circus elephants (Friend & Bushong, 1996), there was no evidence

316   that the activity of painting had such an effect on the elephants in our study. Moreover, painting

317   had no significant effect on the incidents of stereotyped and abnormal behaviour performed in the

318   afternoon.

319   Two elephants performed stereotyped plus abnormal behaviour at similar levels and

320   higher than those of the other two elephants, especially on days when no elephants painted and at

321   all times of the day sampled.   This could, in part, be related to differences in past experience,

322   since performance of stereotypies is known to vary according to age, time spent in captivity and

323   handling by owners/keepers (Mason & Latham, 2004).

324   The types of stereotyped and abnormal behaviour that each elephant displayed varied

325   between individuals; for example, trunk swinging and head-bobbing in C, excessive nipple-

326   rubbing in A, and occasional pacing, trunk swinging and weaving in B.   Elephant D, in captivity

327   for the longest period of time of the four elephants tested (>30 yrs), performed weaving more

328   than the other elephants. The weaving behaviour could have developed as a coping response to

329   stressors resulting from a prolonged amount of time in captivity (Mason, 1991). Other causes of

330   stress-related behaviour include removal from a familiar environment, long-distance transport

331   and integration into a group of foreign animals (Schmid et al., 2001).   These are all events that

332   the elephants at Melbourne Zoo would have experienced at some time.

333   It has also been suggested that elephants may suffer from post-traumatic stress syndrome

334   (Bradshaw et al., 2005) in line with the complex cognitive abilities that have been identified in

335   Asian and African elephants. According to Bradshaw et al. (2005), premature or forced maternal

336   separation, insufficient socialisation, and trauma caused by shock can affect psychological,

337   neurobiological, and behavioural wellbeing of elephants throughout early life and into adulthood.

338   These stressful experiences, many of which are likely to be encountered by elephants in captivity,

339   could influence the development and frequency of stereotyped and abnormal behaviour.

340

341   ***Non-interactive behaviour***

342   The analyses of non-interactive data revealed a significant effect of time of day. Higher scores of

343   non-interactive behaviour were recorded in the afternoon on the day when no painting took place

344   than on the other days. This indicates that not being given the opportunity to paint may increase

345   non-interactive behaviour. Since Carlstead (1996) has found that reduced interactive behaviour is

346   a response to stressful situations, our results suggest that not being selected to paint may be

347   stressful. Closer examination of the performance of non-interactive behaviour by each elephant

348   revealed that one elephant (D) showed more non-interactive behaviour than the others, especially

349   in the afternoon when no painting took place. More waiting at the door to the area for painting

350   would have been expected at midday before the painting session if the elephants were

351   anticipating the activity of painting. Since this did not happen, it seems that the elephants were

352   not anxious to take part in the painting session, apart from elephant D, who did wait at the door

353   more than usual and performed stereotyped behaviour when she had not been selected to paint

354   and this behaviour increased after the other elephants that did paint returned to the yard. It may

355   have been a coping response that D had adopted in order to deal with not being selected to paint.

356   *Behaviour during the painting session*

357   During the painting session two elephants (A and B) spent the majority of time looking at the

358   keeper, whereas the others (C and D) spent the majority of time looking forward toward the

359   canvas with their ears facing forward, indicative of high arousal levels (McKay, 1973). It seems,

360   therefore, that elephants C and D were attending to the painting itself to a greater extent than

361   elephants A and B, the latter relying on visual and auditory cues from the keeper. Elephants A

362   and B spent much of the painting session following the command for 'trunk up'. This position

363   was held while waiting for the next instruction from the keeper and their gaze was usually

364   directed at the keeper at this time. As a reference guide, a chart from Kuhme's (1963) paper on

365   various head, ear and trunk postures associated with aggression, fear and inhibition in African

366 elephants was used to interpret the postures that the elephants were instructed to hold during the

367 painting session. From Kuhme's diagram, the extension of the trunk forward to paint with the

368 ears forward resembles the posture held during increased hostility. The posture with the trunk up

369 resembles conflict between fear, arousal and inhibition. Although these postures were adopted on

370 the keeper's command, they could have influenced the animal's emotional state. Studies have

371 found that when adopting an emotion-specific posture, humans report experiencing the associated

372 emotions of that posture and their preferences and attitudes are influenced (Niedenthal, 2007).

373 The postures that the elephants are instructed to hold could therefore be influencing how they

374 respond to the painting activity, and to the keepers, which might contribute to the differences in

375 behaviour between the four elephants.

376

377 ***Other variables***

378 There was little evidence possible to collect showing that the keeper had a specific role in the

379 behaviour of the elephants and the researchers had no influence on the zoo schedules. The

380 keepers acting as guides for the elephant's painting activities were changed each session, and

381 whoever was on duty administered the sequence of tasks in the same manner. Since we know that

382 elephants recognise individual humans and may develop likes and dislikes to specific people, the

383 human influence on such projects could also form an integral part of any study to eliminate the

384 possibility that elephants respond more to the interaction than to the task.

385

386   Importantly, it is also questionable what elephants saw while they were painting. A very

387 detailed examination of the structure and pigments of elephant eyes suggests that elephants may

388 be colour blind. The detailed study by Yokoyama et al. (2005) found that elephants and colour-

389 blind humans (deuteranopes) have identical sets of visual pigments. Potential colour blindness,

390 and the fact that the keepers selected the paint colour, rather than the elephants doing so

391 themselves, may also affect how stimulating the activity is to the elephant. However, perception

392 of the world by elephants is not entirely clear. A more recent study suggests that elephants can

393 classify humans by odour and garment colour (Bates et al., 2007). This involved testing elephants

394 first using two ethnic groups wearing identical red garments, followed by dressing one ethnic

395 group in white and the other in red. The colour red was selected for the study because this is the

396 colour that Maasai men wear, but it is unfortunate in terms of the findings of Yokoyama et al.

397 (2005) because their findings suggest that red is a colour elephants cannot perceive as a separate

398 colour. However, the white would stand out so clearly that it is not a matter of colour but of light

399 intensity, which made it possible for the elephants to clearly distinguish between the two types of

400 garments. While the title of the paper by Bates et al. (2007) suggests that elephants can

401 distinguish people by colour, this is a little misleading and provides little help for the present

402 study.

403

404 It is of course also possible to relate the activity of painting in elephants to questions about an

405 aesthetic or general artistic sense in (some) animals. The case for an artistic sense has been

406 pleaded for some songbirds and spontaneous responses to rhythm, thought to be unique to

407 humans, have now been shown in some animals, including elephants (Patel & Inversen, 2006;

408 Schachner et al., 2009, Kaplan, 2009) but far more work, and of a different kind than the context

409 of painting elephants for enrichment, would need to be done to expose the extent and the limits of

410 an artistic sense.

411

412

413 **Conclusions**

414

415 The results of this study showed that all four elephants at Melbourne Zoo perform forms of

416 stereotyped behaviour. Since stereotyped behaviour develops as a response to a stressful

417 environment (Selye, 1973; Mason, 1991; Mason & Latham, 2004), we can propose that the

418 environment in which these elephants live induces stress, or they have been exposed to stressful

419 environments in the past, for example maternal deprivation (Latham & Mason, 2008). The

420 elephants were found to perform different levels of stereotyped/abnormal behaviour and two

421 distinct pairs were apparent: A/B exhibited lower levels of stereotyped behaviour than C/D.

422 Since previous research has found that the performance of stereotyped behaviour is a means of

423 coping in a sub-optimal environment (Mason, 1991; Mason & Latham, 2004), and that individual

424 animals performing more stereotyped behaviour generally have lower levels of physiological

425 stress than those that do not perform this behaviour in the same environment (Moberg, 1985;

426 Koolhaas et al., 1999; Matteri et al., 2000), we argue that elephants A and B may be more

427 physiologically stressed than elephants C and D.

428

429 One of the key purposes of providing environmental enrichment for captive animals is to

430 reduce the performance of stereotyped behaviour (Swaisgood & Shepherdson, 2005). The level

431 of stereotyped behaviour of the elephants at Melbourne Zoo was largely unaffected by the

432 activity of painting thus not fulfilling a key purpose of enrichment. They all exhibited stress-

433 related behaviours. Elephants are wide-ranging animals that require abundant space and social

434 interaction for their physiological and psychological needs, needs that a zoo environment cannot

435 reasonably fulfil. A key purpose of including enrichment activities for captive animals is to at

436 least reduce stress-related behaviour as well as encourage natural behaviour and stimulate the

437 animals. The activity of painting does not appear to address this need adequately. Our results

438 suggest that painting does not improve the welfare of elephants and that its main benefit is the

439 aesthetic appeal of these paintings to the public and their subsequent sale where a percentage of

440 funds might be donated toward conservation of the species.

441

442 **Acknowledgements**

443 The research was made possible by the supportive attitude of Melbourne Zoo giving permission

444 for filming and observing the painting sessions and for providing background information on the

445 elephants. The authors gratefully acknowledge their support.

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Table of results for GLM analysis

Table 1 - The results of analysis using repeated measures GLM for each behaviour before and after painting sessions. Significant effects are highlighted in bold.

Behaviour	Main Effect Condition	Main Effect Time	Interaction b/w Condition & Time
Stereotyped/Abnormal	$F_{2, 30}=1.003$, P=0.379	$F_{2,30}= 2.434$, P= 0.105	$F_{4, 60}= 2.452$, P= 0.056
Vocalisations	$F_{2, 22}= 0.007$, P=0.993	$F_{2,22}= 1.674$, P= 0.210	$F_{4, 44}= 0.062$, P=0.993
Interactive	$F_{2, 30}=1.003$, P=0.379	$F_{2,30}= 0.885$, P= 0.423	$F_{4, 60}= 0.994$, P= 0.418
Non-Interactive	$F_{2, 30}= 1.704$, P=0.199	$F_{2,30} = 2.261$, P=0.122	$F_{4, 60}= 2.520$, **P= 0.050**
Exploration	$F_{2, 30}= .422$, P=0.660	$F_{2,30}= 0.466$, P= 0.632	$F_{4, 60}= 1.196$, P= 0.322
Waiting	$F_{2, 30}= 2.091$, P=.141	$F_{2,30} = 2.634$, P= 0.088	$F_{4, 60}= 2.665$, **P= 0.041**

Figure 1

Occurrence of stereotyped and abnormal behaviour

Fig 2 - The mean number of events per elephant (± sem) per 30 minutes of stereotyped plus abnormal behaviour at A) the three different times of the day and in the three conditions. P, the elephant scored engages in the activity of painting; NP, days recorded on which no elephant paints; OP, other elephants paint but not the focal elephant being scored. Each elephant was recorded on twelve days (four repeats for each type of day). Note the lower score in the morning of the day when the elephant is selected to paint and the increase at midday and B) Mean occurrence (±sem) for the individual elephants of stereotyped and abnormal behaviour on days when the focal elephant was not selected to paint. The data are for mean overall number of events per elephant per 30 minutes (three times a day- morning, midday and afternoon) repeated over four days. A, B, C and D refers to the four elephants studied.
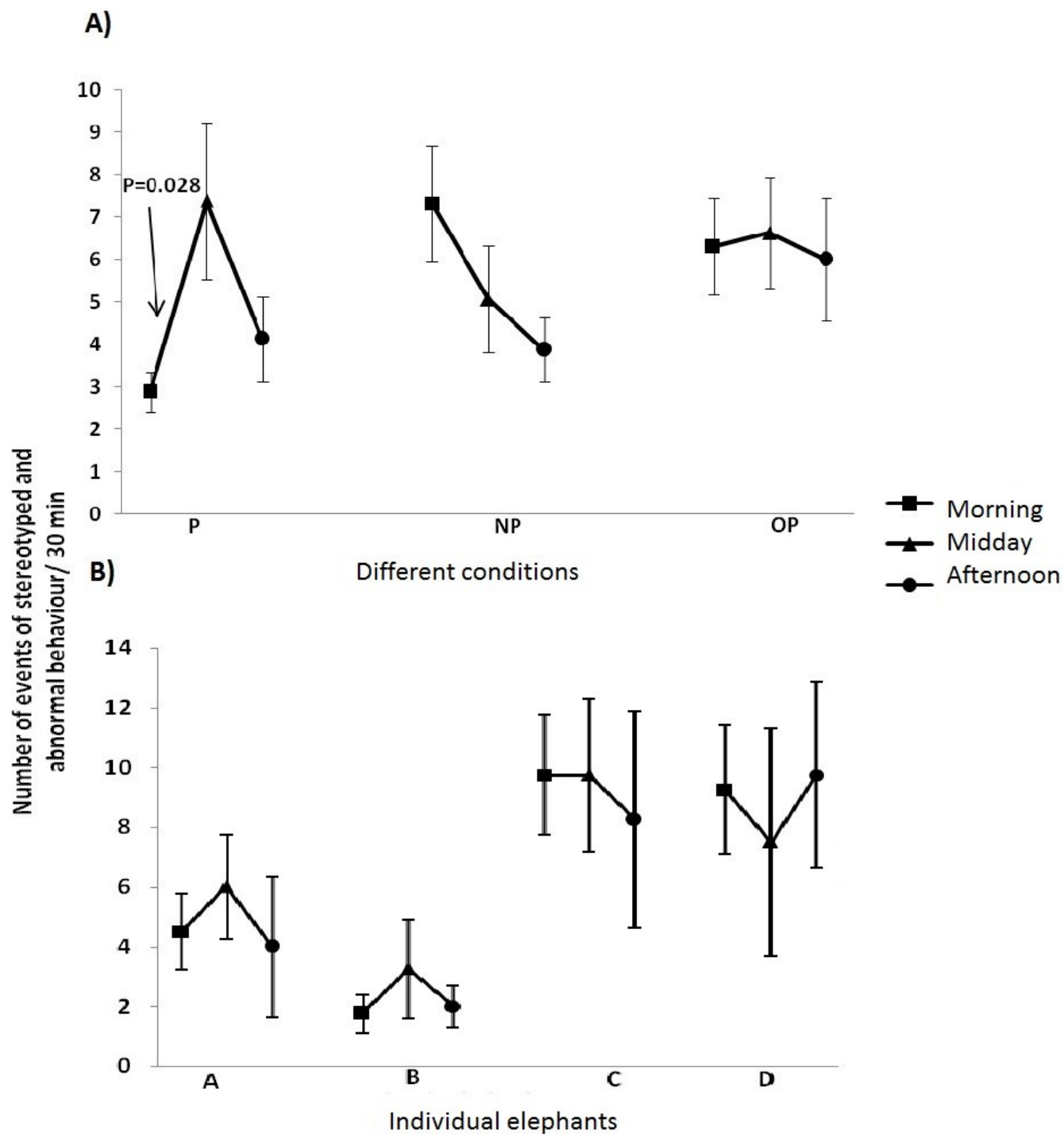
Figure 2

Non-interactive behaviour

Fig 2 - Mean scores (± sem) of non-interactive behaviour at A) different times of the day over the conditions are presented. P, NP and OP refer to the three conditions as in Figure 1 and B) behaviour for each individual elephant on days when no painting took place. A, B, C and D refer to the four elephants studied.
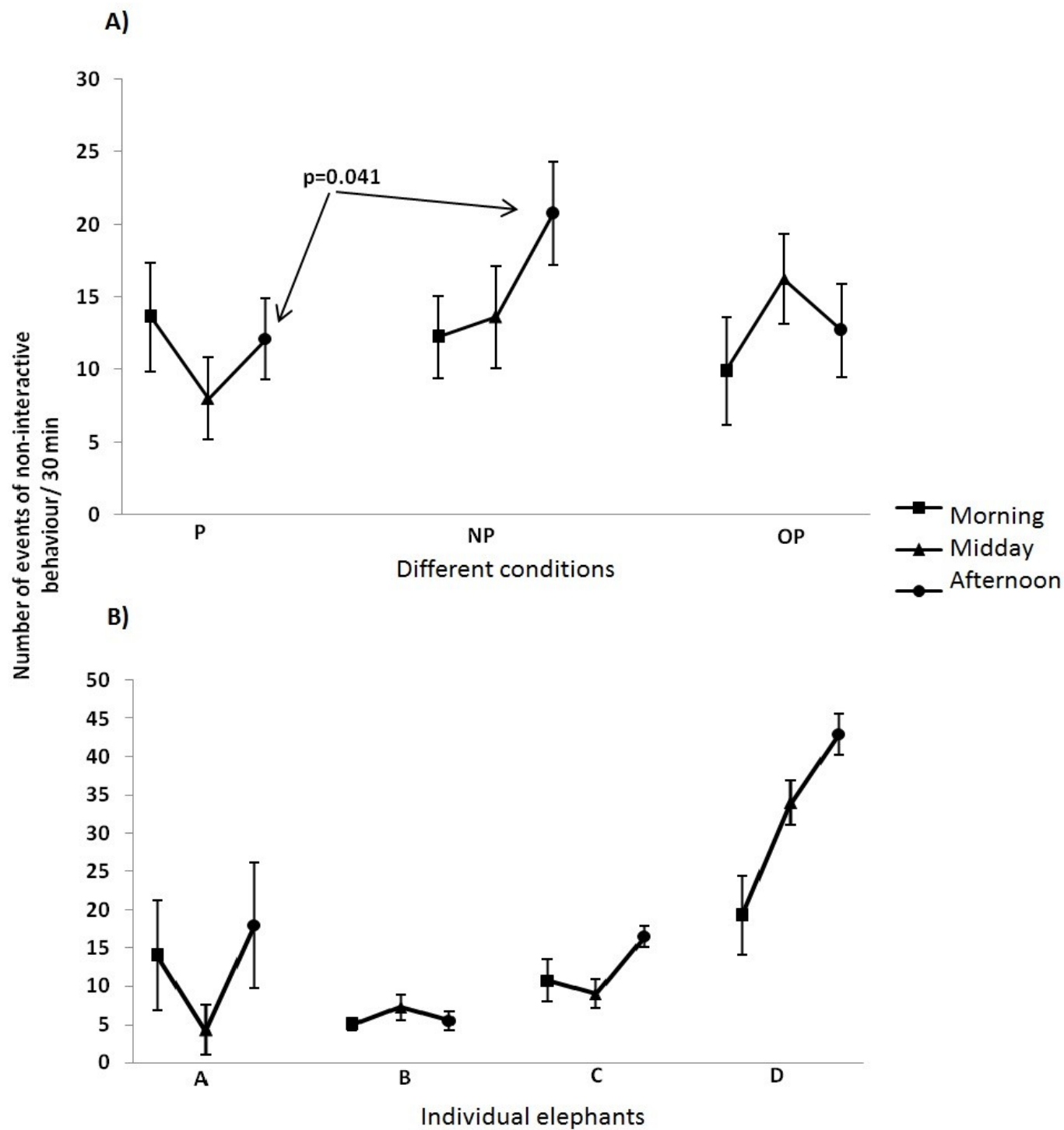
Figure 3

Gaze direction and ear position during painting

Fig 3 -

Mean percentage of time (±sem)

spent

with A) gaze following a particular direction.

Percentages were calculated by dividing mean time gazing in each

direction by total time for which the direction of gaze could be scored. Note the percentage of

time that elephant D

spent looking ahead. Columns marked 'a'

differ significantly from those marked 'b' (p=<.05). The three sections of columns are,

respectively, from the left to the right; looking at the keeper, looking

forward and looking at the scorer and B) [b]

[b] Position of the ears during a painting session, presented as percentage of

time spent with ears in each position. Significant differences between

elephants are shown. **a** and **b** indicate significant differences between elephants. **a** *

and **b** * indicate that elephant B

differed from elephant D in time spent with ears not forward. The four sections of columns,

from left to

right respectively are; forward ear position (45^0- 90^0 from body), not forward

($<45^0$ from body), flapping, and back (<10cm from body).
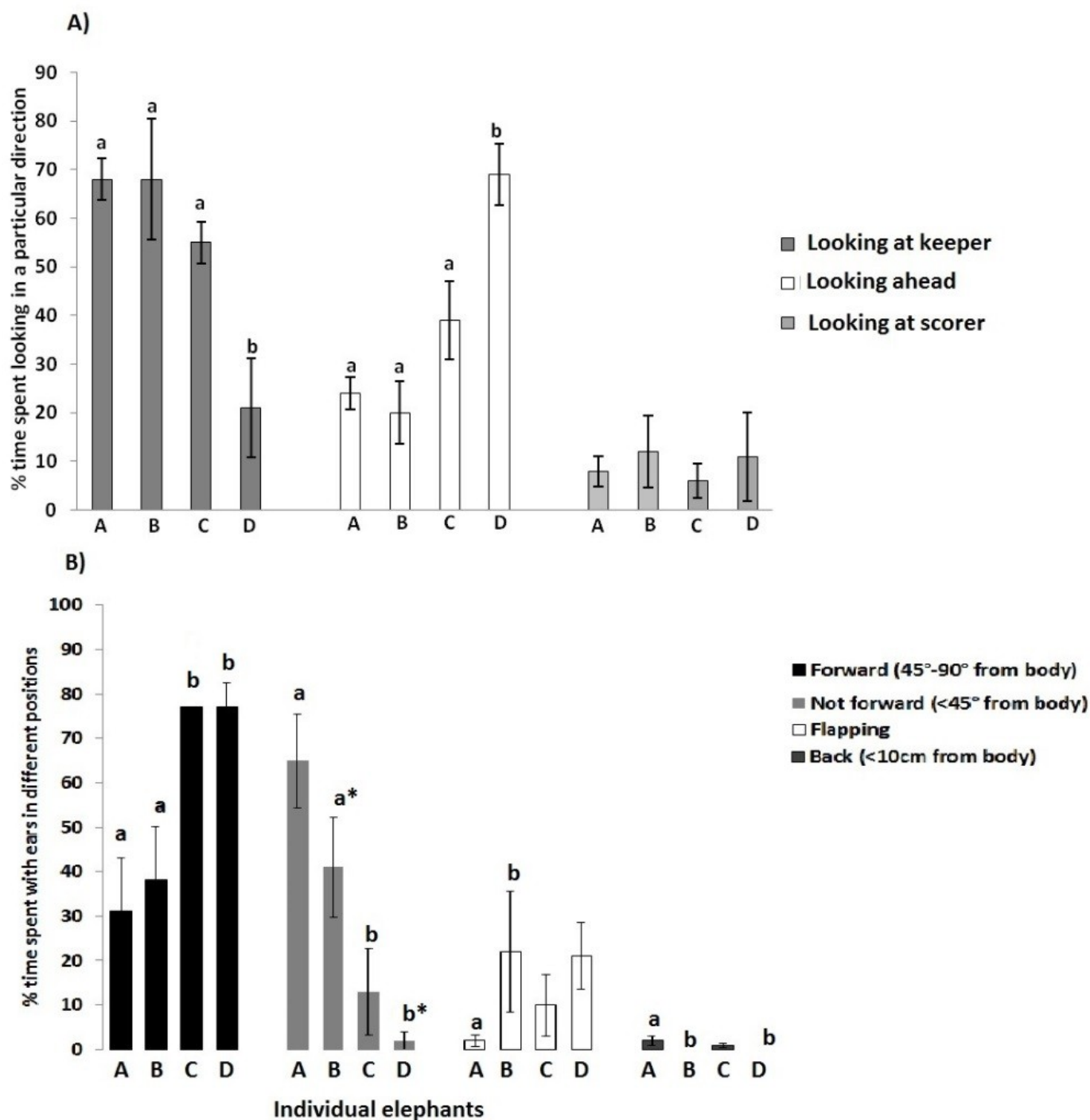
Figure 4

Image of an elephant painting

Fig 4 -

[p] Image of elephant painting at
Melbourne Zoo. [p]