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Happiness is positive welfare

1 **Happiness is positive welfare in brown capuchins (*Sapajus apella*)**

2 **Running title:** Happiness is positive welfare

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Happiness is positive welfare

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Abstract

Welfare questionnaires, which allow people who are familiar with individual animals to rate the welfare of the animals, are an underutilised tool. We designed a 12-item welfare questionnaire and tested its reliability and associations with subjective well-being (SWB), locomotor stereotypy, and personality traits. The welfare questionnaire included questions relating to physical health, stress and coping, satisfaction with social relationships, psychological stimulation, and the display of positive and negative welfare indicators. We collected ratings of 66 brown capuchins (*Sapajus apella*) living in three facilities. Each capuchin was rated on the welfare questionnaire by an average of 2.8 raters. The interrater reliability of the welfare questionnaire items ranged from ICC(3,k) 0.51 to 0.86. A principal components analysis indicated that the 12 welfare items loaded onto one component. We repeated this process with the welfare and subjective well-being items and found all the items were defined by a single component (welfareSWB). We then conducted three sets of analyses, one predicting the welfare component, one predicting the SWB component, and predicting the welfareSWB component. The independent variables were frequency of locomotor stereotypy, personality, age, and sex; facility was included as a random effect. In models including stereotypy, age, and sex we found frequency of stereotypy to be significantly associated with all three predicted components ($p < 0.01$). After controlling for stereotypy ($b = -0.25$, $p = 0.17$), age ($b = -0.54$, $p = 0.01$), and sex ($b = -0.32$, $p = 0.07$), the personality traits of Sociability ($b = 1.02$, $p < 0.001$), Assertiveness, ($b = 0.63$, $p < 0.001$), and Attentiveness ($b = 0.54$, $p = 0.01$) were associated with higher scores on the joint welfareSWB component; Neuroticism was negatively associated ($b = -0.60$, $p = 0.01$). Our results suggest that welfare questionnaires may be a useful, reliable, and valid tool for primate welfare assessment.

Keywords: Brown capuchin, personality, stereotypy, subjective well-being, welfare

Happiness is positive welfare

52 **1. Happiness is positive welfare in brown capuchins (*Sapajus apella*)**

53 People working within animal facilities are an often underutilised source of
54 knowledge for improving animal welfare. These people use their experience to collect and
55 interpret new information and, when shared, their observations can be used to track animal
56 welfare. However, in spite of these capabilities there are few studies using questionnaires to
57 assess animal welfare.

58 The goal of our study was to test the utility of questionnaires as a tool for assessing
59 nonhuman primate welfare. This is an increasingly important area of research given the
60 growing interest in assuring the welfare of animals kept in research facilities. This is also
61 important because in order to improve animal welfare we need to be able to accurately assess
62 it. We chose to study brown capuchin monkeys (*Sapajus apella*) due to the large numbers in
63 captivity (IUCN, 2014) and the fact that there has been extensive research on their behaviour
64 and cognition (Fragaszy et al., 2004). In particular, the personality structure of brown
65 capuchins has been studied (Morton et al., 2013), which presented the opportunity to study
66 the association between ratings of welfare, subjective well-being, and personality.

67 Animal welfare is often assessed using physiological responses and behavioural
68 observations (Broom and Johnson, 1993; Broom, 1988). These methods have drawbacks
69 (Rushen, 1991). For example, blood draws may be stressful, which makes measures of
70 glucocorticoids difficult to interpret (Laule et al., 2003). Behavioural observations, although
71 they do not disrupt the animal, are time-consuming and need to be conducted multiple times
72 to gain an accurate assessment of an individual's welfare state (Vazire et al., 2007).

73 Alternatively, staff can fill out questionnaires, based on their daily observations of animals'
74 behaviours and environmental responses, for a large number of animals in a time-efficient
75 manner. As with other methods of welfare assessment, ratings are not perfect as raters may
76 have individual biases. However, concerns about questionnaire reliability and validity can be
77 assessed by testing the agreement between raters and whether responses are related to
78 observed welfare states. If we can devise reliable and valid questionnaires for rating primate

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Happiness is positive welfare

79 welfare, then facilities housing primates would have one more tool for monitoring and
80 improving welfare.

81 One benefit of questionnaires is that they can cover several indicators and welfare
82 states in a relatively short period of time. In order to more effectively assess welfare it is
83 crucial to assess multiple indices. For example, chronic stress is associated with reduced
84 immune response (Broom, 2006; Cohen et al., 1992) and increased incidence of self-injury
85 (Davenport et al., 2008; Lutz et al., 2003). There is also increased focus on accounting for the
86 experience of positive emotions (or happiness) in welfare assessment (Boissy et al., 2007). A
87 primate welfare questionnaire that covers a diverse set of welfare indicators, including those
88 relating to both positive and negative welfare, could be used to further investigate how
89 different aspects of welfare are interconnected.

90 One questionnaire designed to assess happiness in nonhuman primates is King and
91 Landau's subjective well-being questionnaire (SWB) (2003), which was based on studies of
92 human happiness (Sandvik et al., 1993). This questionnaire was initially used to assess
93 chimpanzees (King and Landau, 2003) and has since been used with other nonhuman species
94 such as *felids* (Gartner and Weiss, 2013) and other nonhuman primates (Weiss et al., 2011a,
95 2011b, 2006). These studies have shown that the interrater and retest reliabilities of animal
96 SWB are similar to those of humans (Diener, 2009). Also, as in humans (Diener and Chan,
97 2011; Diener et al., 2003), happier animals (those with higher SWB) tend to live longer
98 (Weiss et al. 2011) and share certain personality traits, such as higher Extraversion (King and
99 Landau, 2003; Weiss et al., 2009, 2006).

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100 In humans happiness and welfare are directly associated with one another (Diener,
101 2009) suggesting that they are measuring similar constructs. Both animal welfare and SWB
102 involve the animal's ability to cope with their environment and the balance of positive and
103 negative experiences (Broom, 2007; King and Landau, 2003). Does this mean SWB is
104 equivalent to animal welfare? By assessing welfare and SWB in brown capuchins, we can
105 determine the degree to which these constructs are related in this species.

Happiness is positive welfare

106 Accounting for variation in personality has been suggested as another way of
107 understanding and improving captive animal welfare (Tetley and O'Hara, 2012). Studying
108 personality and welfare together may help researchers better understand why animals in a
109 shared environment may have vastly different welfare states. Until now the five brown
110 capuchin personality traits (Assertiveness, Openness, Neuroticism, Sociability, and
111 Attentiveness) have not been studied in connection with welfare and SWB.

112 As such, in this study we assessed the reliability and validity of a 12-item welfare
113 questionnaire in brown capuchins. We then examined the convergence of ratings of welfare
114 and happiness. Finally, we tested the association of ratings of welfare and SWB with
115 locomotor stereotypy and personality traits.

116

117 **2. Methods**

118 **2.1 Ethical Approval**

119 This project was approved by the participating facilities in July 2014. This study was
120 non-invasive and complied with the US Animal Welfare Act (USDA, 2008).

121 **2.2 Subjects**

122 Subjects were 66 brown capuchins (31 males) housed at the National Institutes of
123 Health, Georgia State University, and Franklin & Marshall College. Ages ranged from 0.55
124 years to 45.56 years (mean \pm SD=12.47 years \pm 9.03 years). Across the facilities all the
125 capuchins were socially housed in groups or pairs.

126 **2.3 Instruments**

127 **2.3.1 Welfare questionnaire.**

128 We designed the welfare questionnaire with practicality in mind, and so it was
129 relatively brief and applicable to multiple primate species. The questionnaire is comprised of
130 three sections. The first section asks raters, who were caretakers or other individuals with
131 extensive experience working with the animals that they rated, to answer questions about their
132 experience working with animals. In addition, to prime raters for the welfare questions, this
133 section of the questionnaire asks which physical and behavioural indicators raters use to

Happiness is positive welfare

134 determine whether an animal has positive or negative welfare. The second section consisted
135 of 12 questions based on the five major contributors to animal quality of life proposed by
136 McMillan (2005), including social relationships, mental stimulation, health, stress, and
137 control of the social and physical environment. Some of the definitions and wording were
138 influenced by work by Broom (2007, 1991), Broom and Johnson (1993), and by Green and
139 Mellor (2011). Each of the items could be rated on a five point Likert scale ranging from very
140 bad to very good, altered to fit the question wording and to capture negative and positive
141 welfare states (Boissy et al., 2007; Yeates and Main, 2008). Each question also included a
142 section for comments. The welfare questionnaire is available in [Appendix 1](#).

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143 **2.3.2 Subjective well-being ratings.**

144 We collected subjective well-being ratings for the capuchins using a four-item
145 questionnaire based on King and Landau's questionnaire¹ (2003). This questionnaire asks
146 raters to estimate how often each animal is happy, how satisfying each animal finds their
147 social experiences, how successful the animal is at achieving its goals, and to imagine how
148 happy they would be if they were that animal for a week. Raters used a seven point Likert
149 scale to rate how well each adjective describes the individual animals from "Displays either
150 total absence or negligible amounts of the trait or state" to "Displays extremely large amounts
151 of the trait".

152 **2.3.3 Personality ratings.**

153 We collected personality ratings using the Hominoid Personality Questionnaire², a
154 54-item questionnaire where each item consists of an adjective and one to three descriptive
155 sentences (Weiss et al., 2011b). For example, the item 'fearful' is "**FEARFUL:** Subject reacts
156 excessively to real or imagined threats by displaying behaviours such as screaming,
157 grimacing, running away, or other signs of anxiety or distress." The HPQ uses a seven point

¹ The SWB questionnaire can be found at http://extras.springer.com/2011/978-1-4614-0175-9/weiss_monkey_wellbeing.pdf

² The HPQ can be found at http://extras.springer.com/2011/978-1-4614-0175-9/weiss_monkey_personality.pdf

Happiness is positive welfare

158 Likert scale from “Displays either total absence or negligible amounts of the trait” to
159 “Displays extremely large amounts of the trait”.

160 **2.3.4 Stereotypic behaviour.**

161 We collected data on the frequency of locomotor stereotypy to test the welfare and
162 SWB questionnaires’ relation to an observable welfare state. We asked staff to “Rate how
163 often each animal performs **any of** the following behaviours by placing an X in the
164 appropriate column”. This was followed by operational definitions taken from Vandeleest et
165 al. (2011) for the following stereotypies: pace, flip, twirl, swing, bounce, head twist, and rock.
166 Staff then rated each capuchins’ stereotypic behaviour on a five point frequency scale from
167 “never” to “constantly”.

168 **2.4 Data Collection**

169 We collected welfare questionnaires and subjective well-being ratings from 7 May
170 2014 to 28 August 2014. Ten raters performed 185 ratings of the 66 capuchins using the
171 welfare questionnaire (mean=2.80 ratings per capuchin); nine raters performed 181 ratings
172 using the SWB questionnaire (mean=2.70 ratings per capuchin). Raters knew each capuchin
173 for an average of 3.88 years (range: 0.50 years to 16 years, $SD\pm 3.81$ years). There were 19
174 missing data points out of 2220 possible welfare responses and no missing data points out of
175 724 possible SWB responses. At the same time we collected 64 personality ratings of 18
176 animals. We used 140 personality ratings of 48 of these capuchins previously collected in
177 2010 and reported in Morton et al. (2013). Each of the 66 capuchins was rated on average
178 3.25 times; three animals were only rated once. Overall there were 230 missing data points
179 out of 11016 possible personality responses. Lastly, in December, 2015 we collected 172
180 ratings of stereotypy frequency from seven raters (mean=2.61 ratings per animal); there were
181 no missing data points. All seven raters had contributed to the 2014 data collection. The
182 stereotypy ratings were collected later than the other questionnaires as we decided to test the
183 welfare and SWB questionnaires’ validity by connecting it an observable welfare state, in this
184 case stereotypy. Raters for all the questionnaires were researchers, care staff and/or students

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Happiness is positive welfare

185 familiar with individual animals. For all the questionnaires any item with a missing value was
186 replaced with that items' mean score (Downey and King, 1998).

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187 **2.5 Analysis**

188 Statistical analyses were performed using R, version 3.1.1 (R Development Core
189 Team, 2014).

190 **2.5.1 Intraclass correlations.**

191 We used intraclass correlations (*ICCs*) to assess the interrater reliability of welfare
192 and SWB ratings of the 48 animals that were assessed by multiple raters; the same animals
193 were in both analyses. We also performed *ICCs* to assess the reliability of the personality
194 items for the 63 capuchins that were assessed by multiple raters. *ICC(3,1)* estimates the
195 reliability of single ratings and *ICC(3,k)* assesses the reliability across mean ratings based on
196 *k* raters (Shrout and Fleiss, 1979).

197 **2.5.2 Principal components analyses.**

198 We averaged the welfare item scores across raters leaving a single score per animal
199 and then conducted separate principal component analyses (PCA) for the welfare items and
200 the SWB items. We determined the number of components to extract by examining the scree
201 plot and performing a parallel analysis (Dinno and Dinno, 2010; Horn, 1965). We then
202 computed unit-weighted component scores (Gorsuch, 1983) by assigning a weight of +1 to
203 loadings that were greater than or equal to .4 and a weight of -1 to loadings that were less than
204 or equal to -.4. All other loadings were assigned weights of 0. In the event that an item had a
205 loading greater than or equal to |.4| on more than one component, we assigned the item to the
206 component on which it had the highest loading. We then performed a joint-PCA with the 12
207 welfare items and the four SWB items.

208 To calculate personality component scores we aggregated HPQ item scores across
209 raters and generated component scores for the personality dimensions based on the 2013
210 published structure (Table 6 in Morton et al. 2013). This structure includes five brown
211 capuchin personality dimensions: Assertiveness is made up of items such as *bullying*,
212 *aggressive*, and *dominant*; Openness is made up of items such as *inventive*, *innovative*, and

Happiness is positive welfare

213 *playful*; Neuroticism is made up of items such as (not) *stable*, (not) *predictable*, and *excitable*;
214 Sociability which includes *affectionate*, *friendly*, and (not) *solitary*; Attentiveness is made up
215 of items such as (not) *disorganised*, (not) *unperceptive*, and (not) *thoughtless*.

216 **2.5.3 Pearson correlations.**

217 To examine the associations between personality, welfare, and SWB we used Pearson
218 correlations. After standardising the variables we correlated the personality dimensions and
219 the welfare and SWB items and components. We interpreted the results adjusted for multiple
220 tests using a Holm-Bonferroni correction.

221 **2.5.4 Generalizable linear models.**

222 We fit linear mixed-effects models using the nlme package (Pinheiro et al., 2012). In
223 all models we included age and sex as fixed effects and facility as a random effect. Our
224 dependent variables were the component scores based on the results of the PCAs of the
225 welfare and SWB items Each of these models included three combinations of fixed effects: 1)
226 locomotor stereotypy frequency; 2) the five capuchin personality dimensions; 3) the five
227 personality dimensions and locomotor stereotypy frequency. Locomotor stereotypy frequency
228 was included in models as the aggregation of stereotypy scores across raters. Housing was not
229 included in our models as only three capuchins were reported to ever be pair-housed, the rest
230 were group housed. The dependent variables were converted into z-scores (mean \pm SD=0 \pm
231 1). [The continuous predictor variables (stereotypy, age, and personality dimension) were
232 centred and divided by 2*SD to make the effect size more comparable with the binary
233 variable (sex) (Gelman, 2008). We then calculated conditional R^2 , which gives the variation
234 explained by the fixed and random effects in the model, using the MuMIn package (Barton,
235 2015).]

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3. Results

238 **3.1 Items Interrater Reliabilities**

239 For the welfare items the ICC(3,1) ranged from 0.23 to 0.63 with a mean of 0.45 and
240 the ICC(3,k) ranged from 0.51 to 0.86 with a mean of 0.72 (Table 1). For the SWB items the

Happiness is positive welfare

241 ICC(3,1) ranged from 0.51 to 0.74 with a mean of 0.63 and the ICC(3,*k*) ranged from 0.78 to
242 0.91 with a mean of 0.85 (Table 1). For the HPQ items the ICC(3,1) ranged from 0.12 to 0.74
243 with a mean of 0.39 and the ICC(3,*k*) ranged from 0.30 to 0.90 with a mean of 0.64 (S1). For
244 ratings of stereotypic behaviour the ICC(3,1) was 0.64 and ICC(3,*k*) was 0.82 (*k*=2.61).

245

246 **Table 1**

247 *Interrater reliability of welfare and SWB items*

Item	ICC(3,1)	ICC(3, <i>k</i>)
Social control	0.63	0.86
Number of relationships	0.63	0.86
Physical health	0.56	0.82
Positive/negative experience	0.53	0.80
Quality of relationships	0.49	0.77
Positive welfare	0.46	0.75
Stress frequency	0.46	0.75
Negative welfare	0.45	0.74
Environmental control	0.37	0.67
Effect of experience	0.31	0.61
Psychological stimulation	0.26	0.55
Stress coping	0.23	0.51
Welfare average	0.45	0.72
SWB Goal achievement	0.74	0.91
SWB Happiness as animal	0.64	0.86
SWB Time animal is happy	0.63	0.85
SWB Social satisfaction	0.51	0.78
SWB Average	0.63	0.85

Note. Based on 48 brown capuchins. Welfare items *k*=3.48.
SWB items *k*=3.33.

248

249 **3.2 PCA of Welfare Items and SWB Items**

250 A parallel analysis and scree plot of the welfare items showed a single component
251 (Table 2). When we included both the welfare and SWB items in a joint-PCA we again found
252 a single component. All 16 items had salient loadings on this component (Table 3); we named
253 this component welfareSWB.

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Happiness is positive welfare

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257 **Table 2**

258 *PCA of brown capuchin welfare items*

259

Item	Loading	h^2
Positive/negative experience	0.93	0.87
Number of relationships	0.93	0.86
Stress frequency	-0.90	0.81
Negative welfare	-0.84	0.71
Positive welfare	0.84	0.70
Quality of relationships	0.83	0.69
Social control	0.82	0.67
Environmental control	0.80	0.65
Stress coping	0.72	0.52
Psychological stimulation	0.61	0.38
Effect of experience	0.60	0.36
Physical health	0.50	0.25

260 *Note.* N=66. Proportion of variance=62%. h^2 =commonalities

261

262 **Table 3**

263 *PCA of brown capuchin welfare and subjective well-being items*

Item	Loading	h^2
SWB Happiness as animal	0.93	0.87
Number of relationships	0.93	0.87
SWB Time animal is happy	0.92	0.85
Positive/negative experience	0.92	0.85
Stress frequency	-0.90	0.80
SWB Social satisfaction	0.88	0.78
SWB Goal achievement	0.85	0.73
Social control	0.84	0.71
Quality of relationships	0.83	0.70
Positive welfare	0.83	0.69
Negative welfare	-0.82	0.68
Environmental control	0.76	0.58
Stress coping	0.74	0.54
Effect of experience	0.59	0.35
Psychological stimulation	0.57	0.33
Physical health	0.49	0.24

264 *Note.* N=66. Proportion of variance explained=66%. h^2 =commonalities

Happiness is positive welfare

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266

267 **3.3 Pearson Correlations of Welfare, SWB, and Personality**

268 The welfare component and SWB component were highly correlated ($r=0.91$,
269 $p<0.001$, 95% CI 0.86 to 0.95). Higher Sociability correlated with the higher welfare, higher
270 SWB, and higher welfareSWB scores (Table 4); capuchins rated as more sociable were rated
271 as having better welfare and higher happiness. Assertiveness correlated with the SWB
272 component but not the welfare or welfareSWB components. The full correlation matrix
273 including all items and components is available in Supplementary Table 2.

Happiness is positive welfare

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275 **Table 4**

276 *Pearson correlation coefficients of brown capuchin personality components and welfare and SWB components*

Component	Welfare	95% CI	SWB	95% CI	WelfareSWB	95% CI
Assertiveness	0.37	[0.14,0.56]	0.49	[0.28,0.65]	0.41	[0.18,0.59]
Openness	0.25	[0.01,0.46]	0.27	[-0.03,0.48]	0.26	[0.02,0.47]
Neuroticism	-0.28	[-0.49,-0.05]	-0.24	[-0.46,0.00]	-0.28	[-0.49,-0.04]
Sociability	0.72	[0.58,0.82]	0.69	[0.54,0.80]	0.72	[0.58,0.82]
Attentiveness	-0.19	[-0.41,0.05]	-0.22	[-0.44,0.02]	-0.21	[-0.43,0.04]

277 *Note.* N=66. Boldface values were significant at $p < 0.01$. Adjusted for multiple tests.

Happiness is positive welfare

278 **3.4 Mixed-Effects Models**

279 **3.4.1 Welfare.**

280 In the model that included stereotypy but not personality we found capuchins that
281 performed locomotor stereotypies more frequently were rated as being significantly lower in
282 welfare (see Table 5, left panel). In both the model with the five personality dimensions and
283 in the model that included stereotypy frequency, capuchins lower in Neuroticism and higher
284 in Sociability, Assertiveness, and Attentiveness were rated as having significantly better
285 welfare (see Table 5, middle and right panels).

Happiness is positive welfare

286 **Table 5**

287 *Models of brown capuchin welfare component predicted by stereotypy and personality, controlling for age and sex with facility as a random effect*

Predictor	<i>b</i>	CI	p	<i>b</i>	CI	p	<i>b</i>	CI	p
Intercept	0.18	[-0.22,0.58]	0.042	0.17	[0.07,0.42]	0.008	0.16	[-0.06,0.39]	0.003
Stereotypy	-0.77	[-1.21,-0.33]	<0.001	---	---	---	-0.26	[-0.63,0.10]	0.16
Age	-0.55	[-1.00,-0.10]	0.018	-0.58	[-1.00,-0.15]	0.009	-0.57	[-0.99,-0.15]	0.009
Male	-0.36	[-0.80,0.08]	0.11	-0.38	[-0.72,-0.04]	0.031	-0.35	[-0.69,-0.01]	0.045
Sociability	---	---	---	1.21	[0.76,1.65]	<0.001	1.03	[0.54,1.53]	<0.001
Assertiveness	---	---	---	0.56	[0.20,0.92]	0.003	0.56	[0.20,0.92]	0.003
Openness	---	---	---	-0.28	[-0.76,0.20]	0.23	-0.16	[-0.67,0.35]	0.53
Neuroticism	---	---	---	-0.55	[-1.03,-0.07]	0.025	-0.63	[-1.11,-0.14]	0.012
Attentiveness	---	---	---	0.58	[0.16,1.01]	0.008	0.58	[0.16,1.00]	0.007

288 *Note.* N=66. Boldface values were significant at $p < 0.05$. Variance explained: left panel: $R^2 = 0.31$, middle panel: $R^2 = 0.62$, right panel: $R^2 = 0.62$.

Happiness is positive welfare

289 **3.4.2 SWB.**

290 In the model that included stereotypy but not personality we found that capuchins that
291 performed more stereotypy were rated as as having significantly lower SWB (see Table 6, left
292 panel). In both the model with the five personality dimensions and the model including the
293 personality dimensions and stereotypy, capuchins with higher Sociability and Assertiveness
294 were rated as having significantly higher SWB (see Table 6, middle and right panels). None
295 of the other personality traits were significantly associated with SWB.

Happiness is positive welfare

296 **Table 6**

297 *Models of brown capuchin SWB component predicted by stereotypy and personality, controlling for age and sex with facility as a random effect*

Predictor	<i>b</i>	CI	p	<i>b</i>	CI	p	<i>b</i>	CI	p
Intercept	0.09	[-0.23,0.40]	0.091	0.10	[-0.18,0.39]	0.10	0.10	[-0.17,0.36]	0.099
Stereotypy	-0.68	[-1.14,0.21]	0.005	---	---	---	-0.19	[-0.58,0.19]	0.32
Age	-0.48	[-0.94,-0.01]	0.046	-0.40	[-0.85,0.05]	0.079	-0.40	[-0.84,0.05]	0.078
Male	-0.18	[-0.65,0.29]	0.44	-0.24	[-0.59,0.11]	0.18	-0.22	[-0.58,0.14]	0.22
Sociability	---	---	---	1.13	[0.66,1.59]	<0.001	0.99	[0.47,1.51]	<0.001
Assertiveness	---	---	---	0.79	[0.42,1.16]	<0.001	0.79	[0.41,1.16]	<0.001
Openness	---	---	---	-0.23	[-0.72,0.26]	0.35	-0.14	[-0.67,0.39]	0.59
Neuroticism	---	---	---	-0.40	[-0.90,0.10]	0.11	-0.45	[-0.96,0.05]	0.079
Attentiveness	---	---	---	0.44	[-0.01,0.88]	0.056	0.42	[-0.03,0.86]	0.066

298 *Note.* N=66. Boldface values were significant at $p < 0.05$. Variance explained: left panel: $R^2 = 0.19$, middle panel: $R^2 = 0.60$, right panel: $R^2 = 0.60$.

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299 **3.4.3 WelfareSWB.**

300 In the model that included stereotypy we found that capuchins who displayed
301 stereotypic behaviour more frequently were rated as being significantly lower in welfareSWB
302 (see Table 7, left panel). In the model that included the five personality traits we found that
303 capuchins higher in Sociability, Assertiveness, and Attentiveness and lower in Neuroticism
304 had significantly higher welfareSWB (see Table 7, middle panel). Finally, in the model with
305 the five personality dimensions and stereotypy we again found higher Sociability,
306 Assertiveness, and Attentiveness dimensions and lower Neuroticism were significantly
307 related to higher ratings of welfare and SWB (see Table 7, right panel).

308

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309 **Table 7**

310 *Models of brown capuchin welfareSWB component predicted by stereotypy and personality, controlling for age and sex with facility as a random effect*

Predictor	<i>b</i>	CI	p	<i>b</i>	CI	p	<i>b</i>	CI	p
Intercept	0.15	[-0.22,0.53]	0.047	0.15	[-0.10,0.40]	0.015	0.15	[-0.08,0.38]	0.014
Stereotypy	-0.76	[-1.20,-0.31]	0.001	---	---	---	-0.25	[-0.62,0.11]	0.17
Age	-0.54	[-1.00,-0.09]	0.020	-0.54	[-0.97,-0.12]	0.013	-0.54	[-0.96,-0.12]	0.013
Male	-0.31	[-0.76,0.14]	0.17	-0.34	[-0.68,-0.00]	0.048	-0.32	[-0.65,0.02]	0.070
Sociability	---	---	---	1.19	[0.75,1.63]	<0.001	1.02	[0.53,1.51]	<0.001
Assertiveness	---	---	---	0.63	[0.28,0.99]	<0.001	0.63	[0.28,0.98]	<0.001
Openness	---	---	---	-0.24	[-0.73,0.22]	0.28	-0.14	[-0.64,0.36]	0.57
Neuroticism	---	---	---	-0.53	[-1.01,-0.06]	0.029	-0.60	[-1.08,-0.13]	0.014
Attentiveness	---	---	---	0.55	[0.12,0.97]	0.013	0.54	[0.12,0.95]	0.013

311 *Note.* N=66. Boldface values were significant at $p < 0.05$. Variance explained: left panel: $R^2 = 0.28$, middle panel: $R^2 = 0.63$, right panel: $R^2 = 0.63$.

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312 **3.4.4 Sensitivity test**

313 We conducted sensitivity tests of the models by removing the 18 capuchins that had
314 been concurrently rated on the welfare, SWB, and HPQ questionnaires. We found some
315 effects were no longer significant. However, the effect sizes were largely similar suggesting
316 this was due to loss of statistical power. See Supplementary Tables 3-5 for full models.

317

318 **4. Discussion**

319 We found there was good evidence for staff agreement of ratings of welfare. The
320 welfare items formed a single component. The welfare ratings were correlated with ratings of
321 SWB and formed a single component with SWB items. These results suggest that ratings of
322 happiness and welfare ratings are indistinguishable in brown capuchins. Welfare and SWB
323 ratings were associated with the exhibition of stereotypic behaviour. Finally, four of the five
324 brown capuchin personality dimensions were associated with their welfare, even after
325 adjusting for the presence of locomotor stereotypies. In all models the effect of Sociability
326 and Assertiveness was larger than age, sex, and stereotypy.

327 These findings suggest that facilities housing animals can make use of the knowledge
328 and experience of their staff to collect additional data on animal welfare. The reliability of
329 ratings were relatively high and on par with reliabilities with those in studies of human
330 personality and subjective well-being (Diener, 2009; Gosling, 2001). As suggested by other
331 authors, our results demonstrate that staff members are reliable, credible, and valuable sources
332 of welfare data (Meagher, 2009; Whitham and Wielebnowski, 2009). Additionally, the
333 welfare questionnaire was reported to take as little as three minutes showing the utility of
334 questionnaires as a quick addition to traditional assessment methods. In the future we can
335 expand on this research by examining the validity of welfare ratings in other nonhuman
336 primate species.

337 The welfare items formed a single component suggesting that the aspects of welfare
338 that our questionnaire covered (stress coping, physical health, control, etc.) are connected.
339 Lower welfare and SWB ratings were associated with the higher frequency of stereotypic

Commented [LMR8]: R2 C1

Commented [LMR9]: R2 C4

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340 behaviour. As stereotypy is an abnormal behaviour specific to captivity (Mason, 1991) this
341 suggests that the SWB and welfare questionnaires are measuring an observed welfare state.
342 An alternative explanation may be that raters are familiar with the literature surrounding
343 stereotypy and see it as a negative welfare indicator. Raters who had noted stereotypies were
344 presumably more likely to rate that animal lower in welfare and SWB thus biasing ratings
345 downward. This may be problematic as the literature is mixed regarding the validity of
346 stereotypy as a negative welfare indicator (Mason and Latham, 2004; Mason, 1991). The fact
347 that our stereotypy results validated our welfare and SWB measures still indicates the utility
348 of the measure, but highlights the need for additional metrics that may be less obvious to
349 observers, such as stress hormone levels, to provide further validation.

350 Sociability had the largest effect on welfareSWB, which fits what we know about the
351 importance of primate sociality. Socially deprived primates are prone to self-injury and are at
352 greater risk of displaying stereotypies (Gottlieb et al., 2013; Lutz et al., 2003). Conversely,
353 primates who create high quality social relationships benefit in terms of their psychological
354 and physical health. For example, they have lower stress levels (Shutt et al., 2007; Terry,
355 1970) and reduced parasite loads (Akinyi et al., 2013; Crofoot et al., 2011).

356 We found Assertiveness to have the second largest effect on welfareSWB. The link
357 between Assertiveness and welfare rating may be connected to rank, as a previous study of 38
358 of these subjects found that Assertiveness and alpha status were associated (Lefevre et al.,
359 2014). Within some primate species high rank confers advantages that may lead to better
360 welfare, including primary access to food (Boccia et al., 1988; Janson, 1985; Wittig and
361 Boesch, 2003) and grooming (Coelho Jr et al., 1983; Leinfelder et al., 2001; Parr et al., 1997),
362 and reduced stress levels (Abbott et al., 2003; Sapolsky, 2004). Thus, it may be the link
363 between Assertiveness and alpha status that creates the positive association with welfare and
364 subjective well-being.

365 Personality differences have potential real world applications. For example, Capitanio
366 et al. (2015) found that female rhesus macaques with more similar personalities were more
367 likely to be successfully pair-housed. In addition, personality traits are associated with

Commented [LMR10]: R2 C1

Commented [LMR11]: R2 C1

Happiness is positive welfare

368 chimpanzee self-injurious behaviour (Herrelko et al., 2012) and golden snub-nosed monkey
369 illness duration (Jin et al., 2013). Our study adds to this literature by demonstrating that
370 certain personality traits are associated with welfare ratings, which can be used to more
371 carefully monitor capuchins with these traits.

372 There were limitations to our study. We collected data on locomotor stereotypy using
373 questionnaires but we could not assess the effect of type of stereotypy. Furthermore, we did
374 not examine other types of stereotypical behaviour. This may be important as different types
375 of stereotypy (pacing, rocking, oral) may be related to different aspects of welfare. The
376 stereotypy data was also collected a year after the welfare ratings, which may mean that some
377 of the reported stereotypic behaviour may have developed during that time. However, the
378 strong association between welfare and SWB suggest this may not be the case. Additionally,
379 we included stereotypy to check the validity of the welfare questionnaire, but lacked an
380 equivalent positive welfare indicator such as grooming.

381 The reliability and validity means that this welfare questionnaire, in addition to
382 traditional assessment methods, may be a viable and practical tool. These findings also show
383 that to account for welfare we need to expand our definition to include positive states of
384 subjective well-being or happiness. Finally, this study reaffirms the strong links, identified in
385 other species, including humans, between personality and welfare.

386

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391

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