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1 Running Head: SEA LION PERSONALITY

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4 Personality Dimensions of the Captive California Sea Lion (*Zalophus californianus*)

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Abstract

Although the field of animal personality research is growing, information on sea lion personality is lacking. This is surprising as sea lions are charismatic, cognitively advanced, and relatively accessible for research. In addition, their presence in captivity and frequent interactions with humans allow for them to be closely observed in various contexts. These interactions provide a valuable and unique opportunity to assess dimensions of their personality. This study created a personality survey for captive California sea lions (*Zalophus californianus*) using a three-step approach that balances comprehensiveness and comparability to other species. Zookeepers ($N = 43$) at 5 zoological parks rated sea lions ($N = 16$) on 52 personality traits and 7 training traits. A principal components analysis (PCA) and regularized exploratory factor analysis (REFA) revealed three dimensions (Extraversion/Impulsivity, Dominance/Confidence, and Reactivity/Undependability). Each dimension was significantly correlated with at least one training trait. Pups and juveniles scored significantly higher on Extraversion/Impulsive than adults. No other age or sex effects were present on this or any other dimension. Sea lions are cognitively complex marine mammals that represent a valuable addition to the group of species in which personality structure and function has been studied. The unique behavioral and ecological characteristics of sea lions offer another vantage point for understanding how personality varies between disparate species.

Keywords: social carnivore, pinniped, temperament, marine mammal, survey

40 **Personality Dimensions of Captive California Sea Lions**

41 As early as 40 years ago, researchers had begun developing standardized nonhuman
42 animal personality measures (Gosling & John, 1999; Stevenson-Hinde & Hinde, 2011; Watters
43 & Powell, 2012). The Big Five taxonomy (John, Naumann, & Soto, 2008) is a useful starting
44 point because it posits that a large number of behavioral, cognitive, and affective tendencies (or
45 traits) to be encompassed by five primary factors (Gosling & John, 1999). These factors include
46 Neuroticism, Agreeableness, Extraversion, Openness to Experience, and Conscientiousness
47 (John, Naumann, & Soto, 2008).

48 In nonhuman animals, traits related to Big Five factors can be measured using behavioral
49 coding and/or trait ratings (Watters & Powell, 2012). Unlike behavioral coding, which involves
50 recording the frequency of specific behaviors, rating can draw upon cumulative experiences with
51 that animal (Freeman, Gosling, & Shapiro, 2011; Watters & Powell, 2012). These cumulative
52 experiences are easily aggregated using the rating approach, which eliminates noise from
53 different personal experiences of animal care personnel. For these reasons, primate personality
54 researchers have suggested that the rating approach is superior to coding (Freeman et al., 2011).
55 Although a combination of rating and coding approaches are considered best practice, the use of
56 ratings alone is a robust approach (Freeman et al., 2011; McGarrity, Sinn, Thomas, Marti, &
57 Gosling, 2016; Watters & Powell, 2012).

58 Two strategies have been used for creating personality surveys for use with nonhuman
59 animals: “top down” and “bottom up” (Freeman et al., 2011; Uher, 2008). The “top down”
60 approach stresses comparability and involves adapting existing surveys. However, it risks
61 missing traits unique to the target species (Freeman et al., 2011). The “bottom up” approach is
62 based on the behavioral repertoire of the target species, and therefore surveys developed using

63 this approach are often not comparable to those developed using this approach for other species
64 (Freeman et al., 2011). To harness the strengths and counter the weaknesses of both approaches,
65 Freeman et al. (2011) describe a three-step approach for developing nonhuman animal
66 personality surveys. Briefly, Freeman et al.'s approach involves generating a list of behavioral
67 traits from a variety of sources, eliminating redundancy in those traits, and defining the traits
68 with respect to species-specific behavior. Once a new survey has been created and implemented,
69 inter-rater reliability must be assessed for each trait, and traits that are not reliably assessed are
70 removed from further analysis (Furr, 2011). Lastly, data reduction, either principal components
71 analysis or factor analysis, is used to determine the components or latent variables that the traits
72 define (Furr, 2011).

73 In this study we sought to characterize and assess personality dimensions in the
74 California sea lion (*Zalophus californianus*). We chose to study captive sea lions due to their
75 prevalence in zoos and aquariums, their advanced cognitive abilities (Gisiner & Schusterman,
76 1992; for review see Schusterman, Kastak, & Kastak, 2002), and their ability to form
77 relationships with humans (Schusterman, Gisiner, & Hanggi, 1992). Their frequent interactions
78 with animal care staff afford close observation of the animals in more than one context, making
79 them ideal subjects for cumulative personality ratings. Sea lions are also social carnivores,
80 linking them phylogenetically with dogs (*Canis familiaris*) and hyenas (*Crocuta crocuta*), two
81 species in which personality has been previously studied (Gosling, 1998; Jones & Gosling,
82 2005). Gosling (1998) suggested that social carnivores might be of particular interest in
83 personality studies due to their social sensitivity and ability to form relationships with humans.
84 These attributes may cause social carnivores to share unique personality traits or suites of traits
85 that are distinct from other groups. For example, Malassis and Delfour (2015) demonstrated that

86 California sea lions are able to exploit cues from humans. This led them to propose that the
87 mechanisms that enable California sea lions to utilize human communicative gestures evolved in
88 response to the socially complex environment they inhabit. Studying sea lions thus may offer
89 another perspective on how interspecific social skills are manifested in personality.

90 California sea lion life ecology and social structure also make them interesting subjects
91 for comparative personality research. California sea lions live in large social groups with a
92 polygynous breeding system and show pronounced sexual dimorphism (Peterson &
93 Bartholomew, 1967; Riedman, 1990). Males defend breeding territories on land that
94 aggregations of females move between (Peterson & Bartholomew, 1967). Breeding females
95 direct aggression at conspecifics of both sexes and all ages (Peterson & Bartholomew, 1967).
96 Although there are no systematic studies on sea lion personality, field studies of another species
97 of pinniped, grey seals (*Neophoca cinera*), provide evidence of individually different behavior
98 (Twiss, Culloch, & Pomeroy, 2012; Twiss & Franklin, 2010). Specifically, males showed
99 consistent individual differences in alertness during breeding seasons (Twiss & Franklin, 2010).
100 A later study on both males and females showed that both sexes displayed consistent individual
101 differences in approach and retreat behaviors to a foreign stimulus, and females showed
102 individual differences in pup-checking behavior (Twiss et al., 2012).

103 Because we focus on the personality of captive California sea lions, it is important to note
104 that the individuals in this study participate in training for the majority of their food. Their
105 behaviors and motivations for interacting with keepers are therefore likely influenced by that
106 system and as a result they may have personality dimensions that differ from those of wild sea
107 lions or captive sea lions that are trained using a different system.

108 The goal of the current study was to establish a starting point for understanding sea lion
109 personality using a measure that would facilitate comparison to other studies and use in future
110 combined coding/rating approaches. We created our survey for use with cumulative keeper
111 ratings using the previously described three-step approach (Freeman et al., 2011; Gosling, 1998).

112 **Methods**

113 **Subjects**

114 We studied 18 captive California sea lions (*Zalophus californianus*) that included 8 males
115 (2 pup-juvenile, 6 adult) and 10 females (4 pup-juvenile, 6 adult). Sea lions five years old and
116 older were considered adults (see Table 1 for age, sex and housing information). The sea lions
117 were housed in five different groups among the Wildlife Conservation Society Parks (WCS):
118 Bronx Zoo ($N = 5$), Queens Zoo ($N = 2$), Prospect Park Zoo ($N = 2$), Central Park Zoo ($N = 3$),
119 and the New York Aquarium ($N = 6$). Group compositions varied across facilities and included
120 one all male group at the Queens Zoo, two all female groups at the Prospect Park and Central
121 Park Zoos, and two mixed sex groups at the New York Aquarium and Bronx Zoo (see Table 1
122 for specific age and sex distributions at the different parks). Fifteen of the animals had been born
123 in captivity and three were born in the wild. All sea lions that were rated had been at their
124 facilities for at least one year prior to the survey, but most had been in place for longer. No males
125 were castrated, and pups were naturally weaned.

126 **Survey Construction**

127 Development of the survey was modeled closely after the three-step process used by
128 Gosling (1998). In the first step, a list of 277 traits was generated from three sources: animal
129 personality research (Fagen & Fagen, 1996; Feaver, Mendl, & Bateson, 1986; Gosling, 1998;
130 Highfill & Kuczaj, 2007; Konečná, Weiss, Lhota, & Wallner, 2012; Stevenson-Hinde, Stillwell-

131 Barnes, & Zunz, 1980; Stevenson-Hinde, & Zunz, 1978; Wielebnowski, 1999), human
132 personality research (Goldberg et al., 2006; Saucier, 1994), and input from an expert panel at
133 WCS. The panel was comprised of three experts on California sea lion behavior who had worked
134 with sea lions for many years, and a fourth individual who had studied personality in several
135 nonhuman species.

136 In the second step, redundant and non-applicable traits from the list of 277 terms
137 generated in step one were identified and eliminated. The panel examined the list of terms, and
138 items were also eliminated if they were too subjective or unknowable based on observation.
139 Items were replaced with different terms when panel members felt the definition was appropriate
140 but the term was insufficient and/or misleading and added any additional terms the panel thought
141 should be included.

142 In the third step, the definitions were modified so the behaviors were species-specific and
143 objectively observable. During this step an effort was made to include items of opposite valence
144 (e.g., shy vs. bold) for as many items as possible.

145 The final survey consisted of 52 personality traits accompanied by a definition with
146 respect to sea lion behavior and 7 “training” traits that were deemed to apply only to training and
147 not personality (Supplemental Appendix A). The training trait responses on the survey were
148 analyzed separately. Raters were instructed to indicate on a Likert scale ranging from 1 “not at
149 all like this animal” to 5 “very much like this animal” the degree to which each trait
150 characterized the individual sea lion. At the top of the survey, raters were asked to give
151 information about the nature (i.e. husbandry, training, enrichment, other) and length of their
152 relationship with each animal.

153 **Raters and Trait Assessment**

154 The raters were experienced sea lion animal care staff at WCS. Raters were instructed to
155 fill out the surveys privately and not to discuss their opinions with other raters. They were asked
156 to complete surveys for as many of the sea lions in their facility as they felt comfortable rating. If
157 animals were moved during or immediately prior to the study, trainers at the location in which
158 the animal had spent the most time filled out surveys on that animal (this occurred for one
159 animal). In total, 49 raters returned surveys for one or all of the sea lions with which they had
160 worked. The number of raters per park ranged from 7 to 13.

161 **Data Analysis**

162 *Inclusion criteria and missing values.* Surveys from trainers who had at least one year of
163 experience with an animal were included in the data set to ensure that they had sufficient
164 knowledge of the animal to make accurate personality judgments (for all animals who had been
165 at the facility for at least one year). This ensured that trainers had worked with an animal
166 throughout a variety of seasonal occurrences (breeding, pupping, etc.). At least two surveys were
167 required for each sea lion to be included in the analysis.

168 A small percentage of values were missing (1.3%; 89 out of 6,667). We addressed
169 missing values in the survey by replacing a missing trait score with the mean score on a
170 particular trait, across all sea lions and raters (Morton et al., 2013). This approach is preferred
171 because it does not run the risk of artificially inflating the inter-rater reliabilities of trait items.

172 *Inter-rater reliability of personality ratings.* Inter-rater reliability was calculated for each
173 of the 52 trait items as well as all seven training traits. Intraclass correlations (ICCs) were used to
174 assess inter-rater reliability because of their ability to allow for unbalanced designs (Shrout &
175 Fleiss, 1979; see also Furr, 2011). ICC type 3,1 measures the reliability of an individual trait
176 rating, while ICC type 3,k measures reliability of the average of k trait ratings, where k indicates

177 the number of ratings. As in prior studies (e.g., Freeman et al., 2013), items with ICC(3,1) values
178 above zero were retained for further analysis.

179 *Factor and component analysis.* A regularized exploratory factor analysis (REFA) was
180 run on the reliably rated personality traits (Jung & Lee, 2011). REFA yields unbiased estimates
181 of factor loadings with greater precision relative to principal components analysis (PCA) when
182 using small sample sizes (Jung & Lee, 2011). PCA loadings were included for comparison,
183 however the REFA results were used for all subsequent calculations. We employed Horn's
184 (1965) parallel analysis and a scree plot to determine the number of components or factors to
185 extract. We then applied a varimax rotation to the resulting components or factors. Trait loadings
186 from the REFA with an absolute value greater than .3 were considered salient (large enough to
187 suggest a relationship with the dimension on which they loaded). Unit-weighted trait loadings for
188 each factor were multiplied by each animal's mean trait rating and summed; traits with loadings
189 greater than .3 were assigned a weight of +1, traits loading less than -.3 were assigned a weight
190 of -1, and all remaining items were assigned a weight of zero. No trait had cross loadings,
191 (loadings stronger than .3/-.3 on multiple dimensions) so each item was included in the
192 calculation of only one dimension. The resulting scores were converted into z -scores for further
193 calculations, and also into T -scores ($M = 50$; $SD = 10$) for interpretability. Inter-rater reliability
194 and internal consistency were then calculated for each dimension using the same ICCs used to
195 assess item reliability and with Cronbach's alphas, respectively.

196 Mann-Whitney U tests were used to determine whether there were significant differences
197 between the dimension z -scores for males vs. females and adults vs. juveniles. Mean training
198 traits ratings were correlated with personality dimensions using Kendall's tau-b correlations

199 because data were both non-parametric and ordinal. All analyses were conducted using IBM
200 SPSS 22.0 for Macintosh and/or MATLAB 7.12.0.635.

201 **Results**

202 **Inter-rater reliability of Personality Ratings**

203 The ratings of 43 trainers were included in the final analysis. In total, 16 sea lions were
204 rated, with an average of seven to eight trainers rating each sea lion (2 sea lions were excluded
205 from the analysis because they did not meet the criterion of having surveys from two raters with
206 at least one year of experience each).

207 Of the 52 trait items, only 2, “oblivious” and “unaware”, had ICC(3,1) estimates that did
208 not exceed zero, and were excluded from further analysis. The remaining values were
209 comparable to reliabilities found in other studies (Iwanicki & Lehmann, 2015; Weiss, King, &
210 Hopkins, 2007). The average ICC(3,1) estimate was .370, ranging from .044 for “perceptive to
211 sea lion behavior” to .644 for “cooperative.” The average ICC(3,k) estimate was .761, ranging
212 from .244 for “perceptive to sea lion behavior” to .927 for “cooperative.” Although the
213 reliabilities at the lower bound of the range are low, previous studies have included such items,
214 as any value above zero suggests agreement above chance level (Freeman et al., 2013; Weiss et
215 al., 2007). See Supplemental Appendix B for a full table of ICC values.

216 **Factor and component analysis**

217 The criteria we used to determine the number of factors to extract did not converge on
218 one solution; the scree plot suggested a three-factor solution, while the parallel analysis
219 suggested a two-factor solution. After examining both solutions using REFA and PCA with a
220 varimax rotation, we found that the first factor in the two-factor solution (Supplemental

221 Appendix C) combined the core traits of the first two factors in the three-factor solution
222 (Table 2). The three-factor solution presented groupings of traits that we found easy to interpret

223 and label, while the two-factor solution was less interpretable. Additionally, the three-factor
224 solution accounted for more variance, at 10.6% (REFA) and 73.0% (PCA). We therefore opted
225 to retain the three-factor solution.

226 We multiplied the first and third factor loadings by (-1) to reorient (or reflect) them and
227 facilitate interpretability. We labeled these factors “Extraversion/Impulsivity”,
228 “Dominance/Confidence”, and “Reactivity/Undependability”, respectively. The inter-rater
229 reliabilities of individual ratings, i.e., ICC(3,1) estimates for these factors, were .757, .643, and
230 .716, respectively. The inter-rater reliabilities of mean ratings, i.e., ICC(3,k) estimates for these
231 factors were .957, .927, and .947, respectively. The internal consistency reliabilities, i.e.,
232 Cronbach’s alphas, for these factors were .959, .950, and .951, respectively.

233 *Age and Sex-related Differences.* Full results are presented in Table 3. Only
234 Extraversion/Impulsivity showed an age difference with pup-juveniles ($n = 6$; $Mdn = 31.64$)
235 scoring significantly higher than adults ($n = 10$; $Mdn = 23.63$). There were no sex differences.

236 *Training Traits.* The seven training traits were rated reliably. The average ICC(3,1) for
237 these traits was .425, ranging from .313 for “attentive” to .573 for “eager.” The average ICC(3,k)
238 for these traits was .832, ranging from .763 for “attentive” to .905 for “eager.” See Supplemental
239 Appendix B for all ICC estimates. The training traits “learns slowly” and “learns quickly” were
240 deemed to capture the same construct and therefore we created a composite variable; “learning
241 ability”, defined mathematically as learns quickly – learns slowly.

242 There were several significant correlations between the personality dimensions and
243 training traits (see Table 4). *Learning ability* and *eager* were positively correlated with both
244 Extraversion/Introversion and Dominance/Confidence, and *compliant* was negatively correlated
245 with Reactivity/Unreliability. None of the other correlations were significant.

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Discussion

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The primary goal of this study was to characterize personality in captive California sea lions using trait ratings. We found three dimensions that we labeled Extraversion/Impulsivity, Dominance/Confidence, and Reactivity/Undependability. Because we had no previous sea lion personality research with which to compare our findings, we followed the comparison methods described by Gosling and John (1999). Comparisons were drawn if a dimension's core features reflected one of the Big Five factors or a dimension in another species. Because it is difficult to conceptualize the similarities in personality structure between species for which different labels have been used, we created Table 5, which shows where the sea lion personality traits are found in other species. The clustering patterns of traits demonstrate more clearly the process by which we interpreted our dimensions.

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According to the REFA, three of the four most strongly loading traits on Extraversion/Impulsivity include *playful*, *creative*, and *curious*. These traits are frequently found on dimensions resembling Extraversion, Openness, or both in humans (Goldberg, 1990), chimpanzees (*Pan troglodytes*) (Freeman et al., 2013; King & Figueredo, 1997; Weiss et al., 2009), dogs (Draper, 1995; Jones, 2008), and hyenas (Gosling, 1998). Although *demanding* and *aggressive to sea lions* may seem out of place, both fit with the attention-seeking tendency indicated by the strong loadings of *impulsive* and *jealous*. Additionally, *demanding* has been defined for sea lions as a tendency to solicit attention. In dogs, this trait loads onto Extraversion and Agreeableness (Draper, 1995). Table 5 demonstrates that *aggression* in other species is spread across every dimension (with the exception of the dimension Aggression to Humans). The presence of *aggression* in so many different dimensions could be due to the different contexts that elicit aggressive behaviors in many species. For example, in a review on dog personality

269 studies, Jones & Gosling (2005) found that *aggression* was assigned to many categories and
270 contexts including Fearfulness, Nervousness, and Dominance. Extraverted and impulsive sea
271 lions may more frequently find themselves in social situations that elicit aggression. Sea lions
272 scoring high on this dimension may be more playful and social than lower scorers. They are also
273 likely to be adept at problem solving, as part of the definition for *creative* in our survey included
274 “tries new ways and approaches to reach its goal.” Low scorers, alternatively, may be more
275 solitary and less engaged with others.

276 Dominance/Confidence in sea lions contains traits related to dominance, but also security
277 and fearfulness (see Table 5). This dimension overlaps, for example, with chimpanzee
278 Dominance (Freeman et al., 2013; King & Figueredo, 1997), hyena Assertiveness (Gosling,
279 1998), and Hanuman langur Confidence (*Semnopithecus entellus*) (Konečná et al., 2008). Jones
280 (2008) found that in dogs, *fear* and *submissive* load onto Fearfulness, while dominance related
281 traits load onto Aggression Towards Animals. Dominance and aggression are also linked in
282 hyenas (Gosling, 1998), langurs (Konečná et al., 2008), and chimpanzees (Freeman et al., 2013;
283 King & Figueredo, 1997; Weiss et al., 2009); however, no aggressive traits loaded onto the
284 Dominance/Confidence dimension in sea lions. Perhaps in captivity dominance is expressed
285 without the use of aggression or, in these small, relatively stable groups, there are fewer contests
286 for territoriality. Animal care staff may also discourage aggressive behavior through training and
287 so its prevalence may be low. We included Confidence in the label to highlight the non-
288 aggressive aspects of this dimension. Animals who scored high on this dimension are thus secure
289 and probably able to displace others without the use of aggression. This is likely because low
290 scorers are timid, and submit without contest.

291 Reactivity/Undependability contains traits that reflect low agreeableness and instability.
292 Three traits that load on this dimension-(*cooperative, friendly to people, and aggressive to*
293 *people*) were defined as relating to humans. As a result, it is only possible to directly compare
294 these trait loadings to those from studies of species that included similar traits. In Gosling (1998)
295 the traits *warm* and *obedient* in hyenas were defined similarly to *friendly to people* and
296 *cooperative*, respectively, in sea lions. These traits loaded onto a dimension labeled Human
297 Directed Agreeableness that Gosling (1998) felt reflected social sensitivity. More specifically,
298 Gosling (1998) suggested that a dimension related to agreeableness towards humans might occur
299 in captive populations in which humans occupy a position of relative dominance in the animal's
300 social environment. This type of dominance relationship with humans also applies to dogs. Jones
301 (2008) and Serpell and Hsu (2001) found that in dogs, behaviors related to aggression and
302 friendliness towards people loaded onto a separate dimension than behaviors related to
303 aggression towards dogs. These findings support the view that this phenomenon may be linked to
304 the ability of social carnivores to understand social hierarchies (Gosling, 1998). Sea lions with
305 high scores on Reactivity/Undependability are likely unpredictable and difficult for both humans
306 and sea lions to approach.

307 Each personality dimension that we found in this study is compatible with California sea
308 lion behavior in the wild. California sea lions live in large, gregarious groups (Peterson &
309 Bartholomew, 1967). It therefore makes sense that they would vary on a dimension related to
310 social behavior. It is not surprising that a dominance dimension exists, since males fight to
311 defend and maintain territories and females are often described as "quasi-territorial" during the
312 breeding season (Peterson & Bartholomew, 1967). In the wild, males scoring high on
313 Reactivity/Undependability may be more likely to show aggression during territorial disputes.

314 Females may also manifest this by showing more aggression during the breeding season towards
315 neighboring females.

316 *Training Traits and Personality*

317 All three personality dimensions correlated with at least one aspect of training
318 performance. Extraversion/Impulsivity was most strongly correlated with the training trait *eager*
319 followed by *learning ability*. A willingness to learn (*eager*) and an aptitude at learning (*learning*
320 *ability*) should both be indicative of good trainability. This is supported by other studies that
321 have shown that Extraversion and Openness traits are associated with faster learning (Coleman,
322 Tully, & McMillan, 2005). Dominance/Confidence was also significantly positively correlated
323 with *learning ability* and *eager*. These correlations are consistent with studies that have shown
324 that bold animals learn faster than shy animals (Savastano, Hanson, & McCann, 2003; Svartberg,
325 2002). High Dominance/Confidence animals are less neophobic and will approach novel training
326 stimuli and trainers more quickly (Savastano et al., 2003). Reactivity/Undependability showed a
327 significant negative correlation with *compliance*. It is therefore likely that animals that keepers
328 find unpredictable and irritable are prone to ignoring commands or requiring multiple requests.
329 Carere and Locurto (2011) suggested that reactive animals might have difficulty performing
330 certain behaviors due to anxiety.

331 We found the lack of significant correlation between the trait *breaks often* and any of the
332 personality dimensions particularly surprising. *Breaks often* is defined as a tendency to swim
333 away from a trainer without being asked and/or disengaging from a training session. Coleman et
334 al., (2005) found that exploratory animals tend to lose interest more quickly than others. It is
335 therefore unexpected that Extraversion/Impulsivity did not correlate, as those sea lions display

336 high levels of *curiosity*. The lack of relationship between personality and breaking might indicate
337 that breaking is driven by something else.

338 There were no age or sex effects on personality dimensions, with one exception. Pup-
339 juveniles were rated as being higher in Extraversion/Impulsivity than adults. This is consistent
340 with studies that have shown that Extraversion and Openness decrease during adulthood in
341 domestic cats (*Felis silvestris catus*) and snow leopards (*Panthera uncia*) (Gartner, Powell, &
342 Weiss, 2014), chimpanzees (King, Weiss, & Sisco, 2008; Weiss et al., 2007), gorillas (*Gorilla*
343 *gorilla*) (Kuhar, Stoinski, Lukas, & Maple, 2006), orangutans (*Pongo pygmaeus and Pongo*
344 *abelii*) (Weiss & King, 2015), and observations of California sea lion behavior (Peterson &
345 Bartholomew, 1967). The lack of sex differences in the Extraversion/Impulsivity dimension is
346 consistent with findings with chimpanzees (King et al., 2008; Weiss et al., 2009) and hyenas
347 (Gosling, 1998). Neither Dominance/Confidence nor Reactivity/Undependability showed age or
348 sex differences. This is not consistent with many other species including chimpanzees (King et
349 al., 2008; Weiss et al., 2007) hyenas (Gosling, 1998), and African lions (*Panthera leo*) (Gartner
350 et al., 2014) in which sex differences in the Dominance dimension are present. Dominance also
351 increased with age in chimpanzees (Weiss et al. 2009) and up to a certain age in orangutans
352 (King & Weiss, 2015). The lack of age and sex differences in the Reactivity/Undependability
353 dimension in sea lions is inconsistent with the similar dimension Agreeableness, in humans
354 (McCrae & Terracciano, 2005), and chimpanzees (King et al., 2008). Both humans and
355 chimpanzees show higher levels of Agreeableness in females, and an increase in Agreeableness
356 with age (King et al., 2008; McCrae & Terracciano, 2005;).

357 The lack of significant age and sex effects found in our study could be attributable to the
358 different compositions of ages and sexes at each park and/or the small sample size. Age and sex

359 effects may have been obscured as a result of some of the males being judged relative to one
360 another rather than against females. Furthermore, the social contexts that these animals are in
361 may cause them to behave differently. For example, Peterson and Bartholomew (1967) observed
362 that stable male territories only existed in the presence of females. Perhaps the lack of females at
363 some facilities decreases expressions of male dominance and territoriality.

364 Our study examined California sea lion personality using a framework that would
365 facilitate cross-species comparisons. However, there were limitations to this study. For one, it
366 focused on the development of a personality survey as a step towards understanding sea lion
367 personality. We envisioned that this survey would be paired with behavioral observations in the
368 future, to both test its validity and improve our understanding of sea lion personality. We
369 therefore did not collect additional behavioral data, and as a result it is difficult to validate our
370 findings. However, the correlations between personality dimensions and training traits suggest
371 that the personality ratings were meaningful.

372 This study was conducted on California sea lions living in zoological parks and in an
373 environment in which they are fed primarily during training interactions. Although animal care
374 staff ratings should be based on all observations, including those outside of the training context
375 (on exhibit, during vet visits, etc.), the sea lion behavior most salient to care staff likely occurred
376 during their direct interactions with the sea lions. As such, these results may not generalize to sea
377 lions living in environments in which their receipt of food is not contingent on performance or in
378 the wild. Future studies using this survey to assess personality in other populations of captive sea
379 lions and sea lions in the wild would both test its rigor and help to determine differences between
380 how captive and wild sea lions manifest personality traits.

381 Scientists have called for a better integration of behavioral ecology and personality
382 studies to help gain new insights into personality both human and nonhuman (Sih & Bell, 2008;
383 Weiss & Adams, 2013). For example, Sih and Bell (2008) hoped that we might soon be able to
384 predict behavioral syndromes based on mating systems or ecologies. One step toward this
385 endeavor would be to look into personality similarities in other social carnivores. A further step
386 would examine personality in other species and subspecies of sea lions to further investigate
387 personality differences. With their group living, and advanced cognition, sea lions share traits
388 with very disparate species such as hyenas (Gosling, 1998), dogs (Jones, 2008), and chimpanzees
389 (Weiss et al., 2009). They are a convenient species of marine mammal to research both in
390 captivity and in the wild and could represent a branching point from which to study other species
391 of pinnipeds, caniforms, and other social carnivores.

392 Table 1. *Age, Sex, and Housing of Sea Lions in the Study*

Sea Lion	Age	Sex	Facility
Butch	22	M	Queens Zoo
Taylor	2	M	Queens Zoo
Nav	9	M	Bronx Zoo
Half-Time	2	F	Bronx Zoo
McCabe	1	F	Bronx Zoo
Indy	9	F	Bronx Zoo
Margaretta	3	F	Bronx Zoo
Beebe	13	F	Prospect Park Zoo
Stella	24	F	Prospect Park Zoo
April	22	F	Central Park Zoo
Edith	3	F	Central Park Zoo
Katie	5	F	Central Park Zoo
Duke	10	M	New York Aquarium
Osborn	13	M	New York Aquarium
Bruiser	4	M	New York Aquarium
Diego	9	M	New York Aquarium

394 Table 2. *PCA and REFA Factor Loadings with Varimax Rotation and Three Factors Extracted*

Trait	REFA Loadings			PCA Loadings		
	E/I ^a	D/C	R/U ^a	E/I	R/U	D/C
Creative	0.376	0.147	0.060	0.871*	0.116	0.366
Playful	0.375	-0.015	-0.034	0.913*	-0.119	-0.046
Demanding	0.349	0.232	0.176	0.744*	0.336	0.488
Impulsive	0.332	-0.055	0.259	0.771*	0.544	-0.118
Curious	0.329	0.167	0.049	0.840*	0.096	0.417
Enthusiastic	0.317	0.123	0.035	0.812*	0.104	0.358
Jealous	0.313	0.059	0.194	0.781*	0.462	0.146
Aggressive to SL	0.307	0.142	0.258	0.676*	0.567	0.322
Excitable	0.255	-0.139	0.208	0.663	0.528	-0.328
Lazy	-0.250	-0.110	-0.012	-0.748	-0.054	-0.407
Diligent	0.250	0.116	-0.020	0.681	-0.057	0.404
Active	0.241	0.050	0.007	0.870	0.019	0.203
Aloof	-0.197	-0.013	-0.070	-0.702	-0.228	-0.033
Withdrawn/Asocial	-0.168	-0.042	0.022	-0.644	0.099	-0.172
Alert	0.133	0.036	0.011	0.585	0.048	0.256
Perceptive of H Behavior	0.110	0.093	0.012	0.441	0.016	0.411
Insecure	-0.021	-0.380	0.156	-0.026	0.367	-0.871*
Confident	0.118	0.363	-0.010	0.267	-0.032	0.914*
Submissive	-0.209	-0.353	-0.071	-0.419	-0.172	-0.810*
Dominant	0.266	0.340	0.179	0.466	0.366	0.699*

Neophobic	-0.057	-0.327	-0.023	-0.146	-0.048	-0.879*
Apprehensive	-0.110	-0.323	0.050	-0.257	0.130	-0.792*
Fearful of SL	-0.097	-0.306	0.018	-0.229	0.039	-0.856*
Bold	0.227	0.286	0.087	0.541	0.184	0.684
Shy	-0.180	-0.274	-0.003	-0.523	0.007	-0.814
Focused	-0.039	0.241	-0.102	-0.144	-0.321	0.777
Calm	-0.191	0.233	-0.218	-0.502	-0.532	0.564
Possessive	0.197	0.225	0.109	0.483	0.255	0.554
Fearful of People	0.000	-0.211	0.131	0.004	0.528	-0.815
Unfocused	0.000	-0.204	0.019	-0.004	0.096	-0.758
Intelligent	0.142	0.176	0.075	0.498	0.236	0.644
Flexible	0.121	0.164	-0.160	0.337	-0.481	0.503
Aggressive to People	0.118	0.061	0.402	0.247	0.926*	0.171
Temperamental	0.152	-0.039	0.389	0.346	0.860*	-0.066
Cooperative	-0.108	-0.022	-0.368	-0.267	-0.867*	-0.068
Irritable	0.108	0.075	0.360	0.242	0.850*	0.213
Friendly to People	0.074	0.035	-0.303	0.215	-0.887*	0.109
Erratic	0.200	-0.070	0.30	0.516	0.719	-0.176
Testing	0.226	0.019	0.292	0.548	0.690	0.041
Impatient	0.190	0.067	0.282	0.486	0.735	0.178
Volatile	0.096	-0.115	0.275	0.294	0.818	-0.337
Tense	-0.010	-0.204	0.255	-0.017	0.603	-0.463
Inflexible	-0.053	-0.032	0.249	-0.122	0.753	-0.083

Disobedient	0.138	-0.031	0.243	0.421	0.669	-0.099
Predictable	-0.201	0.061	-0.227	-0.566	-0.643	0.170
Obedient	-0.050	0.032	-0.174	-0.203	-0.563	0.157
Friendly to SL	0.125	0.028	-0.169	0.453	-0.624	0.101
Vocal	0.016	-0.071	-0.153	0.036	-0.340	-0.163
Popular	0.088	0.047	-0.142	0.299	-0.503	0.187
Perceptive of SL Behavior	0.096	-0.006	-0.127	0.436	-0.612	0.000
	Cumulative %: 10.6			Cumulative %: 73.02		

- 395 *Note:* Salient loadings are in boldface (>|.4| for PCA, >|.3| for REFA), E/I =
- 396 Extraversion/Impulsivity, D/C = Dominance/Confidence, R/U = Reactivity/Unreliability, H =
- 397 Human, SL – Sea Lion
- 398 *Salient traits from the REFA analysis.
- 399 ^aLoadings have been reflected

400 Table 3. *Mann-Whitney U Age and Sex Differences in each dimension*

	U	<i>p</i>	<i>z</i>	<i>r</i>
<hr/> Males vs. Females <hr/>				
Extraversion/Impulsivity	23	.368	-.900	-.225
Dominance/Confidence	26	.560	-.583	-.146
Reactivity/Undependability	24	.427	-.794	-.199
<hr/> Pup-Juveniles vs. Adults <hr/>				
Extraversion/Impulsivity	8	.017	-2.39	-.597
Dominance/Confidence	28.5	.871	-.163	-.041
Reactivity/Undependability	21	.329	-.976	-.244

401 *Note: p-values are two tailed*

402 Table 4. *Kendall's tau-b Correlations between Personality Dimensions and Training Traits*

Dimension	Attentive	Breaks Often	Challenging	Compliant	Eager	Learning Ability
Reactivity/Undependability	.03 (.856)	-.14 (.442)	.33 (.078)	-.47 (.013)	.07 (.717)	.25 (.190)
Dominance/Confidence	.33 (.077)	-.25 (.175)	-.36 (.058)	.09 (.650)	.39 (.037)	.52 (.006)
Extroversion/Impulsivity	.17 (.366)	-.14 (.442)	.04 (.821)	-.33 (.077)	.68 (.000)*	.58 (.002)*

403 Note: *p*-values are two-tailed. *Correlations significant after Holm-Bonferroni correction.

404 Table 5. *Mapping of Sea Lion Personality Traits onto Commonly Found Personality Dimensions in Chimpanzees, Humans, Hyenas,*
 405 *Langurs, and Dogs*

Table 5.

Sea Lion	Trait	EXT.	AGR.	EMO.	OPN.	CON.	DOM.	AGG.	AGG.
Dimension				STA.	INT.		FER.	HUM.	INTRA.
					TRN.				
E/I	Creative	C, L			C, H, Y				
	Playful	H, C, D,			C, D, Y		L		D
	Demanding	D	D						
	Curious	D, L, C			C, H, Y		L		
	Impulsive	L	L	C	Y	C			
	Enthusiastic	H							
	Jealous	L	L	H, C	C	C	Y		
	Intraspecific Aggression	C	H, D, L	C	D	C	C, Y, L		D

R/U	Human							D
	Directed							
	Aggression							
	Temperamental			H, C, Y				
	Cooperative		H, C, Y				D	
	Irritable		H, L	C		C		Y, L
	Friendly to		Y			C		D
	People							

D/C	Insecure			H				
	Confident							Y, L, D
	Submissive	H						C, D, L
	Dominant	H	L	C				C, L D
	Neophobic							
	Apprehensive	L	L			C		C
	Fearful			H, C				C, D, L, Y

406 *Note:* EXT (Extraversion), AGR (Agreeableness), EMO STA (Emotional Stability), OPN INT TRN (Openness, Intellect,
407 Trainability), CON (Conscientiousness), DOM FER (Dominance, Fearfulness), AGG HUM (Aggression to Humans), AGG INTRA
408 (Intraspecific Aggression)
409 E/I (Extraversion/Impulsivity), R/U (Reactivity/Undependability), D/C (Dominance/Confidence)
410 C = chimpanzees, H = humans, Y = hyenas, L = langurs, D = dogs

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