PERSONALITY AND AFFILIATION INVOLVING A COOPERATIVE TASK IN BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) DYADS

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ABSTRACT

Cooperation may be related to personality in bottlenose dolphin (*Tursiops truncatus*) dyads. Five bottlenose dolphin pairs at the Roatan Institute for Marine Sciences, Honduras, were presented with an apparatus released a food reward if opened cooperatively. I created personality profiles of each dolphin with traits grouped in two different contexts: dolphin-dolphin and dolphin-world. I hypothesized that the success of the cooperative task would be related to similarities in socialization and dissimilar in interacting with objects. None of the dolphin pairs cooperated to open the apparatus. I then analyzed individual personalities in relation to the dolphins' individual and mutual interactions with the apparatus as well as the pairs' social behaviors. Playfulness, curiosity, and affiliativeness as well as the factors openness, agreeableness, and extraversion were positively related to affiliation with the apparatus and each other. My findings could guide future animal research on the relationship between personality, social interactions, and problem-solving.

DEDICATION

I would first like to dedicate this thesis to my family, without whom this would not have been possible. To my son, Nicholi, who motivates me and reminds me anything is possible. To John, who's greatest expression of love has been allowing me to unapologetically follow my heart. Lastly for my mother, who gave me everything.

I would also like to dedicate my work to Stan Kuczaj. You cultivated passion for animals and helped me mold it into more than I thought it could be. I am privileged to have had your mentorship and your guidance shaped the scientist I've become. I hope to make you proud in this and in the future.

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CHAPTER I

INTRODUCTION

Cooperation

Cooperation among animals is defined as two or more individuals acting together in order to achieve a mutually desired outcome (Boesch & Boesch, 1989). Many social species share commonalities in communal behaviors such as rearing of young, predator defense, and the acquiring and sharing of food (Drea & Carter, 2009). A variety of different species have the ability to cooperate, including orangutans (*Pongo pygmaeus*) (Chalmeau, Lardeux, Brandibas, & Gallo, 1997), spotted hyenas (*Crocuta crocuta*) (Drea & Carter, 2009), bottlenose dolphins (*Tursiops truncatus*) (Kuczaj, Winship, & Eskelinen, 2015), tufted capuchin monkeys (*Cebus paella*) (Hattori, Kuroshima, & Fujita, 2005), rats (*Rattus norvegicus*) (Łopuch & Popik, 2011), African grey parrots (*Psittacus erithacus*) (Péron, Rat-Fischer, Lalot, Nagle, & Bovet, 2011), Asian elephants (*Elephas maximus*) (Plotnik, Lair, Suphachoksahakun, & De Waal, 2011), rooks (*Corvus frugilegus*) (Seed, Clayton, & Emery, 2008), meerkats (*Suricata suricatta*) (English, Nakagawa, & Clutton-Brock, 2010), cotton-top tamarins (*Saguinus oedipus*) (Snowdon & Cronin, 2007), and insects (Fewell, 2003). In the wild, animals are seen working together in many different ways; however, when recreating this phenomenon experimentally, strategies to induce cooperation are often limited to food acquisition.

In the lab, a variety of animal species have shown the ability to simultaneously pull ropes in order to receive a food reward which is sometimes referred to as the rope pulling task. Such

species include, Asian elephants (*Elephas maximus*) (Plotnik et al., 2011) orangutans (Chalmeau et al., 1997), and spotted hyenas (*Crocuta crocuta*) (Drea & Carter, 2009) . In Southeast Asia, six pairs of captive elephants learned the rope pulling task and if one elephant was delayed in its approach to the apparatus, the other elephant would wait before beginning (Plotnik et al., 2011). Orangutans were able to learn a similar task in which two handles had to be pulled at the same time by two individuals. One of the most significant indicators of cooperation was that the two primates would look to each other before pulling on the apparatus indicating that they were accounting for each other's actions (Chalmeau et al., 1997). Drea and Carter (2009) conducted two different string-pulling experiments with spotted hyenas. In the first cooperative experiment, the subjects were exposed to the apparatus as dyads and as tetrads. It was found that they were able to simultaneously pull the ropes as a pair to retrieve the food reward. The researchers also created dyads of one experienced individual and one naïve individual in order to determine if the hyenas would account for the behavior and knowledge of the other. The experienced subject would adapt its behavior to account for the inexperienced hyena in order to achieve cooperative success (Drea & Carter, 2009). The most significant indicator of cooperation in these experiments was that at least one of the cooperating animals accounted for the behavior of the partner and adjusted its own actions accordingly.

In the wild, some predatory animals engage in cooperative hunting and specific populations often use strategies that are adapted to be most successful for the hunters based on the prey and the environment. For example, Harris' hawks have been seen cooperatively hunting and killing prey larger than themselves. The most common method involved multiple birds bombarding the prey animal from different directions (Bednarz, 1988). Orca whales (*Orcinus orca*) in the Antarctic employ an interesting tactic called wave-washing. Wave-washing occurs

when a group swims together just under the water's surface, creating a wave that washes over the block of ice, pushing a seal or penguin into the water on the other side, where another group is waiting (Visser et al., 2008).

Another Delphinidae species that exhibits several different cooperative hunting strategies is the bottlenose dolphin (*Tursiops truncatus*) (Connor, 2010). In the Florida Keys, groups of dolphins have been seen participating in what is known as mud plume feeding. When this method is used, a group of dolphins will herd prey fish into a tight group and one or two dolphins will beat their flukes against the ocean floor. The disturbance stirs the muddy bottom and creates a plume around the school, effectively confining and confusing them. Rather than swim through the mud cloud, the fish attempt to escape by jumping out of the water and over the ring. The dolphins wait on the outside of the plume to catch the fish in the air (Lewis & Schroeder, 2003).

Elsewhere in Florida, a similar situation has been recorded that has been called the driver barrier method. These dolphins participate in individual specialization where one individual in each group is consistently assigned the role of driver. This dolphin will circle a school of fish into a tight ball and "push" them towards the rest of the group who are the barriers. The barriers, or non-drivers, help keep the fish together without letting them escape, making feeding for all individuals easier (Gazda, Connor, Edgar, & Cox, 2005). Another example comes from an estuary in South Carolina where a local population of bottlenose dolphins have been documented strand-feeding since 1995 (Petricig, 1995). Strand-feeding is when three or four dolphins line up side-by-side facing the shore and swim forward together creating a wave which pushes the fish and the dolphins onto the muddy bank where the dolphins will feed on their prey before returning to the water (Duffy-Echevarria, Connor, & St Aubin, 2008). This procedure is similar

to the wave-washing tactic seen in Orcas (Duffy-Echevarria et al., 2008; Visser et al., 2008). This affiliative hunting observed in groups of carnivores is perhaps supported or induced by their social structures.

Personality

Living closely with others in hierarchies requires animals to be able to relate to and understand other individuals. This ability could encourage high cohesion when engaging in group goal-directed behaviors, such as hunting. These animals benefit from their successful cooperation by achieving goals they could not otherwise reach on their own, such as capturing bigger prey (Drea & Carter, 2009). One of the ways that populations maximize success in these endeavors is role specification in which certain individuals to fill unique niches within the community. It has been speculated that there may be a relationships between individual personalities and what role they tend to fill (Bergmüller & Taborsky, 2010). While role specification is usually discussed in terms of filling roles throughout the community as a whole such as caregiver or leader, it is also applicable to small subsets such as hunting groups. When individuals work together but use different strategies, it can increase the quality and success rate of an interaction in that different options or "points of view" can be explored (McNamara & Leimar, 2010). The more variety there is within the group the better equipped the group will be as a whole to deal with any situations that may arise (Bergmüller, Schürch, & Hamilton, 2010). When individuals work together, some pairs or groups are more effective than others (Dall, Houston, & McNamara, 2004). These individualized behavioral strategies are sometimes observed in conjunction with individualized roles within a community. Such stable inter-individual differences influence other aspects of life aside from hunting such as competition,

defense, habitat use, and reaction to novel stimulus (Réale, Reader, Sol, McDougall, & Dingemanse, 2007; Webster & Ward, 2011). These consistent differences in behavior are sometimes attributed to different personalities arising within these compartmentalized social groups (Bergmüller & Taborsky, 2010).

Personality or stable inter-individual differences that persist over time, is a topic of growing interest within the study of animal behavior, but an in-depth understanding of how personality affects individual social interactions is needed (Gosling, 2008; Webster & Ward, 2011). Personality research with social animals has focused on the effect that individual personalities have on the group as a whole. Great tits are birds that tend to reside in social groups with a variety of personalities. A population was observed while exploring new areas containing feeders and results showed a distribution of personality is related to habitat use with different personalities resulting in high cohesiveness and exploration (Aplin, Farine, Mann, & Sheldon, 2014). Group behavior in Rhesus macaques is dependent on the individual personalities within that group (Uher, 2008). However, when studying animals that live in these social communities it is important to consider them not only as a group, but also as many individuals with personal relationships. Some personalities are more advantageous than others in specific situations (Sih, Bell, & Johnson, 2004) and in interactions with other individuals as well (Wolf & Weissing, 2012). Personality not only has an effect on how individuals interact with each other, but also with how individuals interact with the environment. Often, specific intricacies in personalities, known sometimes as traits are correlated with responsiveness to novel objects. For instance, male great tits that are more aggressive tend to be more explorative and interactive with novel situations and objects (Sih & Bell, 2008; Verbeek, Drent, & Wiepkema, 1994). An individual's

inclination toward social behavior is also thought to have an impact on how readily that individual will learn cooperatively (Hall et al., 1988).

A less commonly explored personality dynamic is social interactions among small groups of individuals such as dyads (Webster & Ward, 2011). Whereas some social activities, including hunting and foraging, require several individuals filling a variety of niches, other activities such as the rearing of young requires cooperation between two individuals. Thus, the roles that need to be filled may be different. Scrub jays tend to partner with mates who display similar behaviors as themselves and these pairs tend to have more success reproducing and rearing chicks. Even if each pair uses a different parenting strategy, the success rate stays high as long as both birds within the pair have similar behavioral repertories (Gabriel & Black, 2012) Recently, a study of the bottlenose dolphins at the Roatan Institute for Marine Sciences (RIMS) explored the relationship and personalities between paired individuals. The dolphins formed the closest bond with those to whom they were similar in conscientiousness but different from in extraversion and neuroticism (Moreno, 2017).

In the wild, dolphins live in groups called pods the smallest of which usually contain around 10 individuals (Louis et al., 2014). These pods are social but nomadic and are fission-fusion societies. In this form of social structure, the individuals in any one pod are constantly changing as multiple pods cross paths (Mann, Connor, Tyack, & Whitehead, 2000); however, it is common for certain individuals to form long-term bonds with each other and become dyads that travel and change pods together (Connor, Smolker, & Richards, 1992). Similarly, dolphins in captivity also form long-term dyadic relationships (Moreno, 2017) . Both captive and wild populations of dolphins form social bonds and hierarchies, but how this is decided among the pod remains unknown (Highfill & Kuczaj, 2010). This consistency in social behavior across the

captive and wild populations makes captive dolphins the ideal subject for research on cooperation. The similarities of affiliative behavior between the two populations could mean that the relationship variables found among captive dyads are generalizable to wild populations as well. Bottlenose dolphins that are kept in captivity are often trained to perform behaviors as synchronous pairs; however, experimental inquiries into bottlenose dolphin cooperative behavior are few (Kuczaj et al., 2015). This lack of research may be due to the difficulty of executing cooperative rope-pulling tasks with marine life because of the aquatic environment and lack the range of appendage movement that land animals have (King, Allen, Connor, & Jaakkola, 2016).

Kuczaj et al. (2015) investigated a novel problem-solving task with three captive populations of bottlenose dolphins. Each group was presented with a cylindrical apparatus that required the dolphins to pull a rope on either end to release a food reward (see Figure 1). This task encourages cooperation as it is the easiest method to obtain the fish inside. When the task was presented to a group of six dolphins, two dominant adult males learned the task and promptly monopolized the apparatus. Although they cooperated successfully, it remains to be seen what factors caused the increase in their success rate when compared to the other subjects at other locations that did not participate in cooperative behaviors. The authors speculated that personality might be a factor, but this theory was not assessed.

Bottlenose dolphins are popular subjects for behavioral research and have distinct personalities that persist over time and across contexts (Highfill & Kuczaj II, 2007). Dolphins are social animals and thus depend on conspecifics for a variety of daily tasks. This dependence may cause individuals to develop different standard behaviors and reactions so that they may contribute to the well-being of the entire group (Bergmüller & Taborsky, 2010).

Present Study

I researched dolphins' affiliative and interactive behaviors when exposed to a novel apparatus in pairs and how these behaviors related to the personality of the individual dolphins. Personality profiles of each of 10 bottlenose dolphins were compiled using surveys completed by the resident trainers. The dolphin pairs were presented with an apparatus that could be opened cooperatively. Personality traits were correlated with categories of behaviors that were observed during trials. I hypothesized that dyadic success would differ based on specific personality traits of individuals. Specifically, based on results from previous research (Bergmüller & Taborsky, 2010), I expected that the most successful dyads would be similar in how they socialized with conspecifics and different in how they approached objects as this would allow the pair to communicate and fulfill specific roles. Gaining this knowledge could aid in increasing the quality of life in managed care facilities by decreasing potential stress by understanding which animals will work best together. It could also help further our understanding of the cognitive functioning of bottlenose dolphins to help protect and conserve this and similar species (Carere & Locurto, 2011).

CHAPTER 2

METHOD

Materials

Personality Survey

A dolphin personality scale was used to quantify each dolphin's personality. The scale was derived from previous research by Kuczaj et al., (2012) that examined personality traits in a variety of contexts. The survey was comprised of personality traits in two different contexts: dolphin interacts with dolphin and dolphin interacts with object. The first section asked the raters to give a numeric value for adjectives that described how the individual dolphin interacted with the physical environment. The adjectives included: curiosity, confidence, observance, playfulness, creativity, and timid-boldness. The second section asked the raters to give a numeric value for descriptions about how the dolphin interacts with other dolphins. The adjectives for this section included: playfulness, observance, tolerance, solitariness, curiosity, submissiveness, aggressiveness, shy-boldness, and affiliativeness with partner.

Each trait was rated on a 7-point Likert scale (see Appendix B). The surveys were set up in such a way that the most extreme rating of traits was "1" and the least extreme manifestation of traits were rated as "7"; the only exception to this was the trait "bold" in both contexts where the rating of "5" was the least bold and "7" was the boldest while "1" was the most extreme rating for timid or shy and "3" was the least. It is important to note that the scale used in the personality surveys assigned the highest ranking of traits to the lower numeric values. For

example, a dolphin rated highest on curiosity (“extremely curious”) received a numeric value of “1”. The only trait that was an exception to this was Bold in which boldness was represented in the ratings 5-7 and the lower ratings of 1-3 represented timid or shy. In order to simplify the understanding of the results, trait ratings were reversed so that the most extreme expression of the traits were represented by the largest value: 7.

Apparatus

The problem-solving apparatus was a 17” long PVC pipe sealed on both ends with a cap, one of which was removable (see Figure 1). From each cap a loop of soft, black rope protruded to allow the dolphins to grip the caps of the apparatus and pull them to open the device. The inside contained herring or capelin fish and ice as the food reward for opening the apparatus.

Two GoPro Hero3 cameras were fitted to the apparatus, one GoPro Hero5 underwater and a Sony camcorder above water were used to record the sessions for coding purposes.

Figure 1

Apparatus (source: Winship, 2015)

Facility and Subjects

The study was conducted at the dolphin housing facility of RIMS located on Bailey's Key off the coast of Roatan, Honduras (see Figure 2). The lagoon housed 19 dolphins; it was enclosed on all sides by a wooden dock above water and netting below water. The enclosure included a beach and the water ranged from a depth of 0m-7m with an area of approximately 800m^2. The natural enclosure included sand, coral, sea grass, and free-swimming fish. Testing occurred in the smaller enclosures reserved for individualized training (indicated by red arrow in Figure 2). Subjects included ten RIMS dolphins, eight males and two females (see table 1). Dolphins were paired according to which individuals work together most often and were as follows: Ronnie and Mr. French, Bill and Ritchie, Han Solo and Hector, Polly and Tilly, Champion and Lenca.

Table 1 Demographics of Participating Dolphins at the RIMS Facility

Name	Sex	Age
Bill	M	15 years
Ronnie	M	14 years
Hector	M	>13 years (wild born)
Ritchie	M	13 years
Mr. French	M	12 years
Han Solo	M	>6 years (wild born)
Champ	M	6 years
Lenca	M	6 years
Tilly	F	6 years
Polly	F	6 years

Figure 2

An aerial view of Bailey's Key (arrow points to enclosures where testing took place)

Procedure

Personality

Personality surveys were distributed through Qualtrics, a web-based survey tool (Qualtrics, 2013)(see Appendix B for full survey). Surveys were completed by three staff members from the facility who rated behaviors that coincide with personality traits for each of the ten dolphins. Two consistent raters were used who completed surveys on all ten dolphins: the assistant director of RIMS and the most senior trainer, the third profile for each dolphin was completed by another RIMS trainer that had the most experience with that individual dolphin.

Training

Prior to testing, some dolphins were given a basic introduction to the apparatus to ensure they understood how the object works and to alleviate any fear of a novel item. Due to time

restrictions and dolphin availability, only some of the dolphins received training (see table 4 for list of training sessions). Each session began with an exposure. After the exposure, the trainer refilled the apparatus, offered one of the loops to the dolphin. The dolphin was given a secondary reinforcement (bridge) and primary reinforcement (fish) for touching the rope with his or her rostrum. The trainer then began asking the dolphin to open his or her mouth and then placed the rope inside and closed the dolphin's mouth. The dolphin was reinforced for biting down on the rope. Once the dolphin was comfortable with biting the rope, the apparatus was placed in the water and the dolphin was reinforced for allowing the apparatus to free float while holding the rope. This was to ensure that the dolphin was comfortable with the large object floating by his or her face. The final stage of training involved the dolphin holding the rope and pulling backwards or down to pull the top off. The dolphins were given secondary reinforcement for pulling and primary reinforcement for opening the apparatus.

Table 2 List of Training Sessions With Dates

Dolphin	Training Sessions	Dates
Han Solo	3	Aug. 1, 2017 Aug. 2, 2017 Aug. 4, 2017
Bill	3	Aug. 4, 2017 Aug. 8, 2017 Aug. 10, 2017
Ritchie	3	Aug. 1, 2017 Aug. 4, 2017 Aug. 8, 2017
Mr. French	4	Aug. 1, 2017 Aug. 7, 2017 Aug. 8, 2017 Aug. 10, 2017
Ronnie	5	Aug. 1, 2017 Aug. 3, 2017 Aug. 4, 2017 Aug. 7, 2017 Aug. 8, 2017
Polly	1	Aug. 1, 2017
Tilly	1	Aug. 1, 2017

Testing

Testing was conducted in one or two sessions per day, on August 9 and August 13-18, 2017 (see table 5 for list of trials). Each session consisted of one 10-minute trial. There was one instance where a session consisted of two trials due to the apparatus coming open by mistake; this error ended the trial early. Once Bill and Ritchie consumed the fish that spilled out, the apparatus was reset, and another trial was immediately run. There was an increase in paired interactions with the apparatus and social behaviors from the first trial to the second.

For each phase of the testing, the selected pair was isolated in a separate, enclosed training space attached to the back of the lagoon (see Figure 2). The researcher and assistants sat on the dock surrounding the enclosure at locations ideal for video recording or note taking. Teri Bolton, the assistant director of RIMS and head trainer, placed the apparatus in the water either from a floating platform or the dock and stepped away from the enclosure or sat down on the dock. Activity on the docks surrounding the enclosure were ceased prior to and during the trials; however, stimulus from other dolphins in neighboring enclosure or from boats outside the enclosure could not be controlled. The dolphins received no form of primary or secondary reinforcements during trials. Prior to each trial, the pair of dolphins were brought to an upright position side-by-side in front of the floating platform or the dock depending on which enclosure was in use for an exposure. The exposure procedure was as follows: the apparatus was filled with fish and ice and the cap was placed on the end. The trainer then showed the end of the apparatus to the pair of dolphins before pulling on the rope and releasing the contents into the water. After the dolphins ingested the fish, the apparatus was refilled and tossed into the center of the enclosure. The trial time started once the apparatus touched the water.

The start of the trials was immediately preceded by an exposure. After the contents were consumed, the apparatus was re-loaded and thrown into the water and was retrieved at the end of the 10 minutes. At the end of each trial, the trainer the apparatus was retrieved by the researcher or an assistant either from the dock or by entering the water. The researcher, assistants, and director observed and noted the dolphin's behaviors towards each other and the apparatus for the duration of the trial. The end of each trial was followed by the opening of the apparatus in front of the dolphins and the food contents were poured into the enclosure for the dolphins to consume.

Table 3 List of Trials for Each Pair and Number of Behaviors in Each Category

Dolphin Pair	Trial Number	Trial Date	Individual Interactions with Apparatus	Pair Interactions with Apparatus	Social Behaviors
Han Solo & Hector	1	Aug 9	Han Solo: 3 Hector: 5	2	0
	2	Aug 14	Han Solo: 0 Hector: 0	0	0
	3	Aug 15	Han Solo: 10 Hector: 2	1	1
	4	Aug 16	Han Solo: 1 Hector: 8	0	2
	5	Aug 16	Han Solo: 13 Hector: 16	9	3
	6	Aug 17	Han Solo: 2 Hector: 4	0	2
	7	Aug 18	Han Solo: 6 Hector: 9	1	1
Bill & Ritchie	1	Aug 9	Bill: 14 Ritchie: 20	0	1
	2	Aug 9	Bill: 12 Ritchie: 18	4	4
	3	Aug 13	Bill: 0 Ritchie: 0	0	1
	4	Aug 15	Bill: 14 Ritchie: 20	0	2
	5	Aug 16	Bill: 14 Ritchie: 4	0	2
	6	Aug 17	Bill: 19 Ritchie: 24	0	4
Mr. French & Ronnie	1	Aug 9	French: 24 Ronnie: 19	0	0
	2	Aug 13	French: 8 Ronnie: 26	1	8

	3	Aug 14	French: 3 Ronnie: 5	0	1
	4	Aug 15	French: 33 Ronnie: 20	8	11
	5	Aug 16	French: 23 Ronnie: 29	5	7
	6	Aug 17	French: 15 Ronnie: 18	6	7
	7	Aug 18	French: 25 Ronnie: 22	3	2
Champion & Lenca	1	Aug 14	Champ: 10 Lenca: 5	0	5
	2	Aug 15	Champ: 51 Lenca: 43	1	3
	3	Aug 16	Champ: 45 Lenca: 42	10	10
	4	Aug 17	Champ: 31 Lenca: 32	3	4
	5	Aug 18	Champ: 39 Lenca: 24	0	3
Polly & Tilly	1	Aug 14	Polly: 76 Tilly: 21	2	13
	2	Aug 15	Polly: 13 Tilly: 17	0	8

Coding

Videos of the trials were analyzed for interactive behavior and affiliative behavior using an all-occurrence sampling method (Altmann, 1974; Kuczaj et al., 2015). Frequency of dolphin behaviors were coded using an ethogram (see Appendix C) and Behavioral Observation Research Interactive Software (BORIS) (Friard & Gamba, 2016) video coding program. Each trial was recorded from four different perspectives: two on the apparatus facing towards either end, one above water, and one below water. Not all of these videos were usable; therefore, for coding, each trial had a minimum of one video and a maximum of four videos. For the trials that had multiple videos, the times were synchronized so that behaviors could be most accurately accounted for. For example, a continuation of one behavior from above water to below water would be counted as one behavior rather than two. The distribution of the number of videos per trial across all pairs varied evenly so certain pairs were not disproportionally represented.

Behaviors were grouped into three categories: individual interaction with apparatus, paired interaction with apparatus, and social interactions. Overall number of behaviors per group were determined for each dolphin. Since each pair completed a different number of trials, the number of behaviors in each group was divided by the number of trials.

CHAPTER 3

RESULTS

Although none of the pairs opened the apparatus, the dolphins did interact with it as well as affiliated with each other offering the opportunity to explore interactions with a novel object and affiliation in relation to personalities. The average frequency of behaviors in each category for each individual can be seen in Table 4.

Table 4 Average Frequency of Behaviors in Each Category for Each Individual

Dolphin	Individual Interactions	Paired Interactions	Social
Hector	6.29	1.86	1.43
Han Solo	5	1.86	1.43
Mr. French	18.71	3.29	5.14
Ronnie	19.86	3.29	5.14
Bill	12.17	0.67	2.33
Ritchie	14.33	0.67	2.33
Polly	44.5	1.00	5
Tilly	19	1.00	5
Champion	33.2	2.80	10.5
Lenca	29.3	2.80	10.5

Personality

Three types of profiles for each dolphin were created by averaging the three ratings of each trait. Bill was the only dolphin where none of the raters showed significant interrater

reliability. His profile was comprised of the ratings of Teri Bolton, the rater with the most experience with Bill. The first profile for each dolphin included average ratings of all traits (see Figure 3 and 4). The second combined all the traits into the five factor traits: openness, conscientiousness, extroversion, agreeableness, neuroticism (OCEAN) (see Figure 5). The categorization of traits was based on Kuczaj et al. (2012) (see Appendix D) and an average for each of the factors was created. The third profile also aggregated traits into the five factors but only included the three traits that had significant judge agreement: playful (DPW), aggressive, and affiliative (see Figure 6). Graphs of each profile for each individual dolphin can be found in Appendix E.

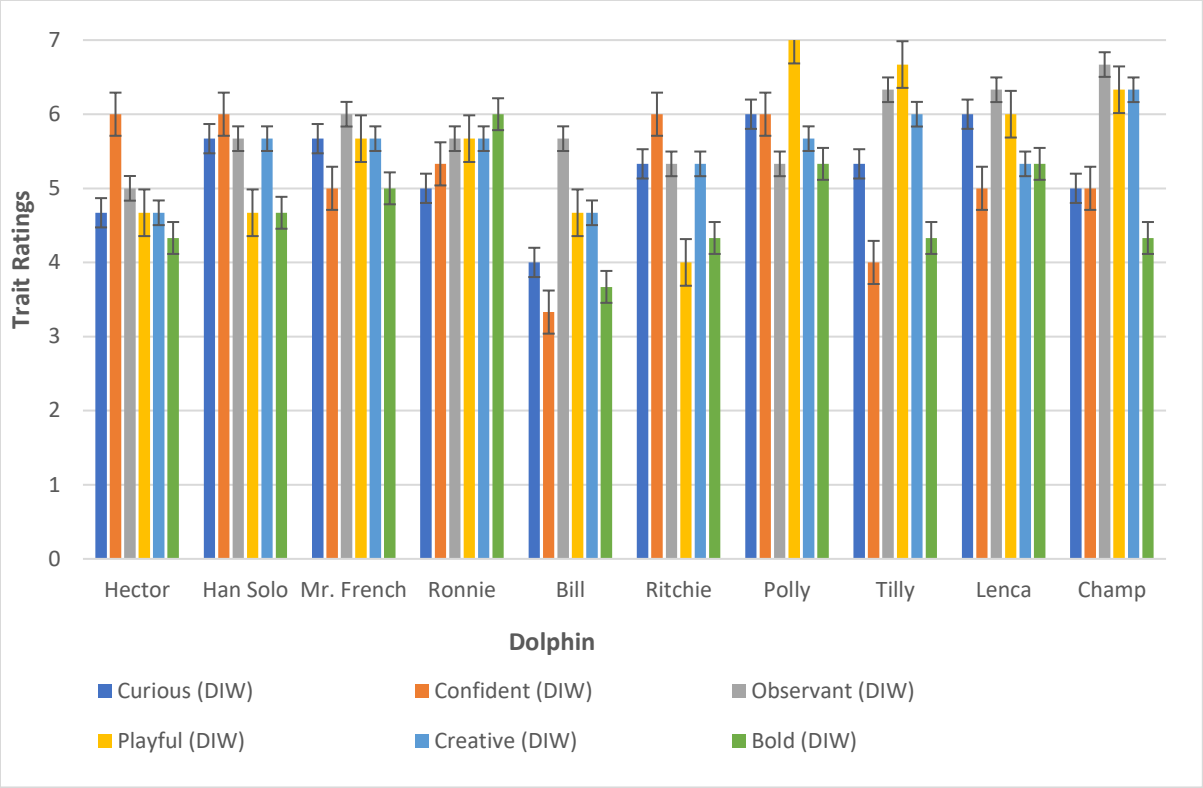

Figure 3

Bar chart depicting each dolphin's average rating for each trait in context of "dolphin interacts with physical world"

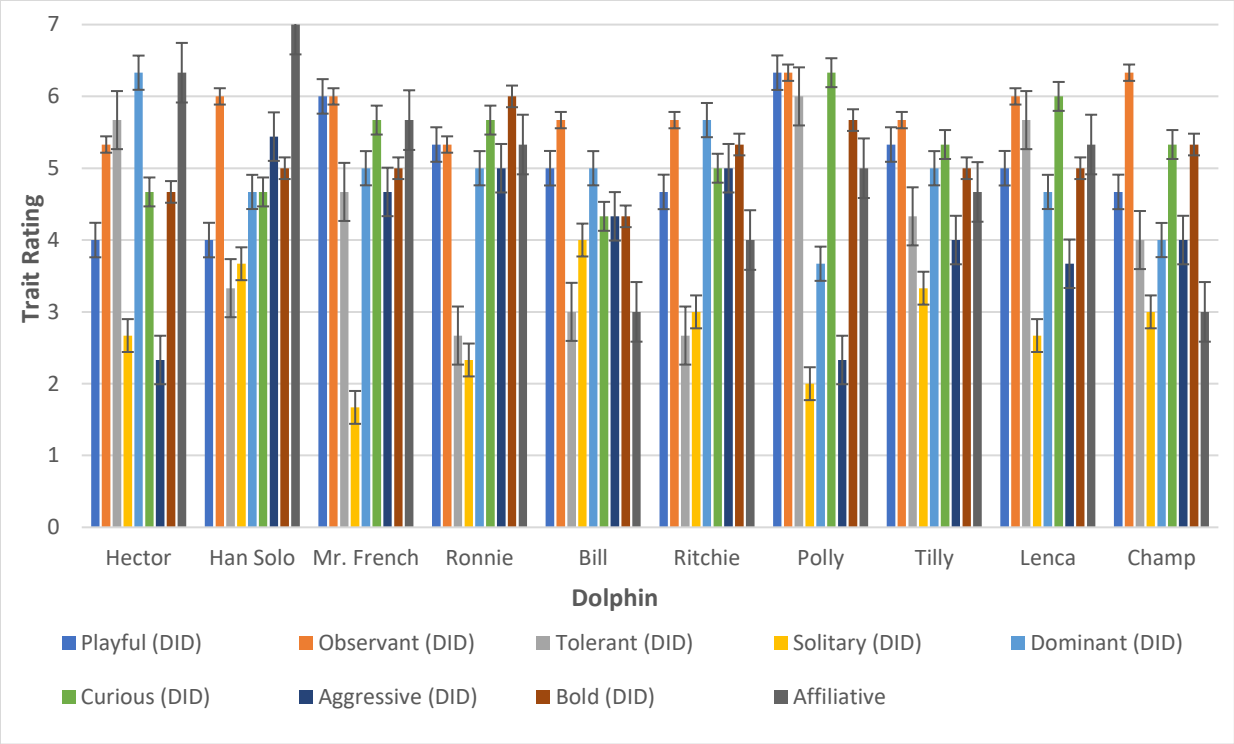

Figure 4

Bar chart depicting each dolphin's average rating for each trait in context of "dolphin interacts with dolphin"

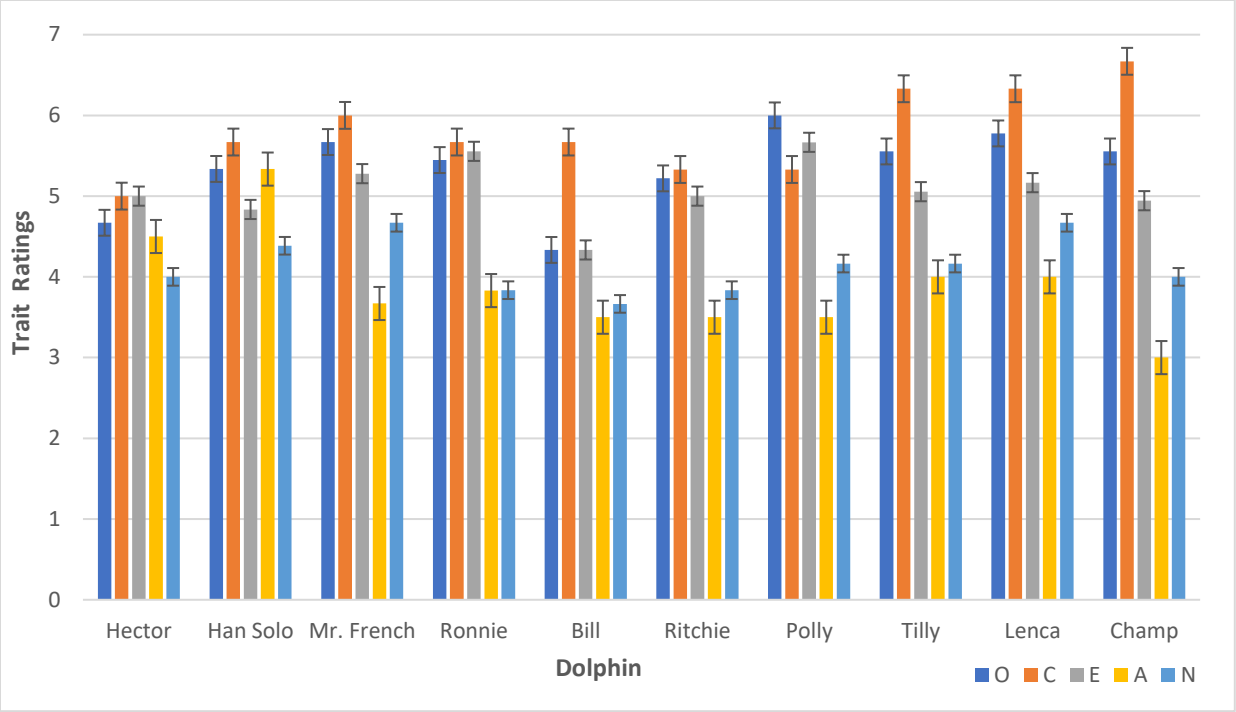

Figure 5

Bar chart depicting each dolphin's average rating for each of the 5 dimensions (Openness to experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism)

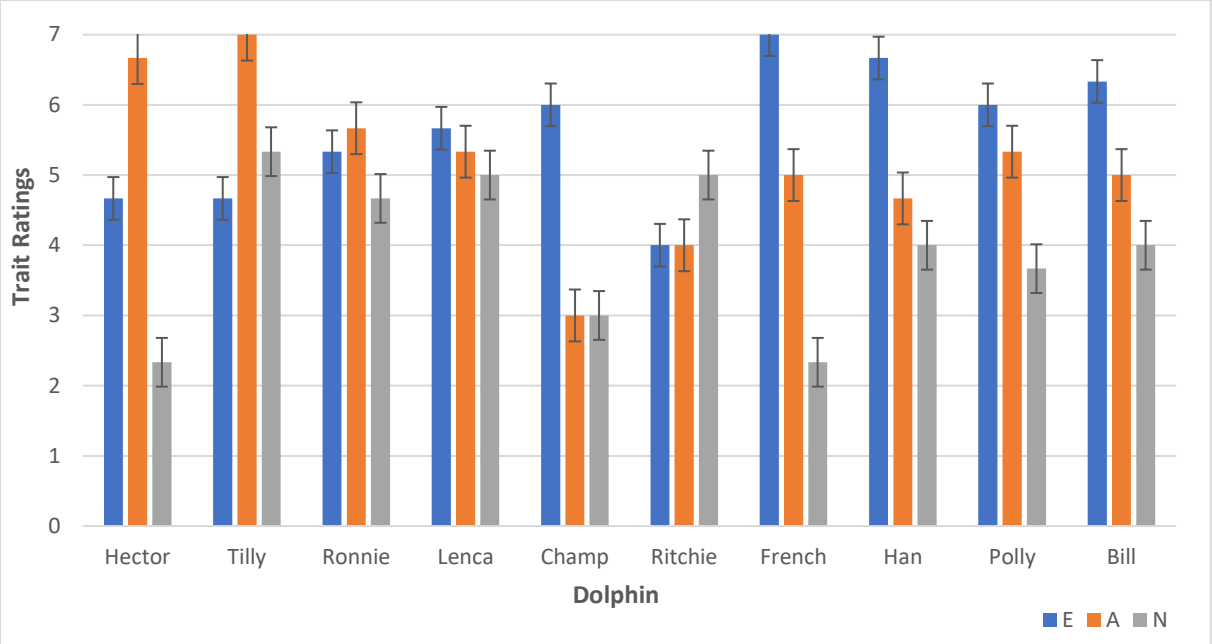

Figure 6

Bar graph depicting average ratings for each dolphin in the three dimensions with significant judge-agreement (Extraversion, Agreeableness, Neuroticism)

All of the dyads consisted of individuals with similar rankings in personality traits. To examine the possibility that the individuals in the tested dyads were more or less similar than other potential pairings of individuals, a pseudo-couple analysis was conducted. A dyadic index was created for each tested dyad by averaging the difference between individual ratings of traits. Additionally, a dyad level measure of pseudo-couple dissimilarity was determined by averaging the dyadic index of all other possible dyads (see Table 6). Then, a paired samples t-test was run to test and found no significant difference between the dyadic indexes (M=0.988, SD=.444) and the dyad level measures of pseudo-couple dissimilarity (M=1.139, SD=0.270); t(4)=-0.374, p=.596. This means that none of the possible dyads that could have been created would have personality dynamics significantly different than the dyads that were used.

Table 5 Listing of Pseudo-Couple Analysis Values

Dolphin	Dyadic Index	Dyad Level Measure of Pseudo-Couple Dissimilarity
Hector and Han Solo	0.898	1.070
Mr. French and Ronnie	0.600	0.867
Bill and Ritchie	1.733	1.489
Polly and Tilly	0.999	0.923
Champion and Lenca	0.712	1.347

For each dolphin, interrater reliability was determined between the three raters using Kendall's coefficient of concordance (Kendall's W). For comparison, a parametric measure of interrater reliability was conducted using Intraclass correlations (ICC [2,1]). Both analyses showed that all three raters were reliable for nine of the ten dolphins (see Table 8).

Table 6 Nonparametric (Kendall's W) and Parametric (ICC [2,1]) Measures of Interrater Reliability of Raters Among Dolphins

Dolphin	W	P	ICC (2,1) (α)	P
Hector	.846	.001	.852	.000
Han Solo	.614	.027	.650	.009
Mr. French	.664	.015	.810	.000
Ronnie	.754	.004	.900	.000
Bill	.447	.173	.211	.286
Ritchie	.790	.003	.861	.000
Polly	.867	.001	.952	.000
Tilly	.618	.026	.566	.029
Lenca	.695	.010	.794	.000
Champion	.783	.003	.821	.000

Additionally, agreement on traits between raters was determined using Kendall's W, ICC (2,1), and rWG (see Table 5). Traits that had a significant W as well as high agreement (>.8) in ICC (2,1) and rWG included playful in "dolphin interacts with physical world", aggressive, and affiliative. Tolerant was the only trait to have a significant W but an ICC_2 and rWG of < .8.

Table 7 Nonparametric (Kendall's W) and Parametric (ICC (2,1) and rWG) Measures of Rater Agreement Among Traits

Traits	W	P	ICC (2,1)	rWG
Curiosity (DPW)	.308	.503	-.195	.592
Confidence (DPW)	.527	.115	.461	.658
Observant (DPW)	.403	.283	-.011	.808
Playful (DPW)	.830	.008	.896	.917
Creative (DPW)	.463	.187	.157	.825
Bold (DPW)	.172	.863	-.699	.408
Playful (DID)	.585	.071	.328	.708
Observant (DID)	.350	.396	-.627	.842
Tolerant (DID)	.652	.040	.647	.567
Solitary (DID)	.474	.172	.365	.75
Dominant (DID)	.425	.244	.375	.733
Curious (DID)	.398	.293	.391	.808
Aggressive (DID)	.831	.008	.879	.900
Bold (DID)	.187	.831	-.273	.783
Affiliative	.774	.013	.837	.833

Video Reliability

Twenty percent of the total videos were coded by the researcher (KCB) and a research assistant (AM) for reliability. Reliability was assessed using Cohens kappa and was accepted with a minimum of .8. All videos met the criteria with a minimum of k = .805 and an average of k = 0.866 and a standard deviation of 0.037.

Comparison of Behaviors and Personality

Kendall's tau-b correlations were performed to compare groups of behaviors to personalities of individual dolphins. Comparisons of all personality traits to the three behavior categories (individual interactions with apparatus, paired interactions with apparatus, and social) showed moderate to strong positive correlations between "individual interactions with apparatus" and "playfulness" in "dolphin interacts with physical world", $T_b = .614$, $p = 0.015$ (see Figure 7); "individual interaction with apparatus" and "curiosity" in "dolphin interacts with dolphin", $T_b = 0.768$, $p = 0.003$ (see Figure 8). Moderate correlations were also found between "paired interaction with apparatus" and "affiliative", $T_b = 0.530$, $p = 0.043$ (see Figure 9). Additionally, significant, positive correlations between "social" behaviors and "playfulness" in "dolphin interacts with physical world", $T_b = 0.555$, $p = .034$ (see Figure 10); "social" and "playfulness" in "dolphin interacts with dolphin", $T_b = 0.815$, $p = 0.002$ (see Figure 11); "social" and "curiosity" in "dolphin interacts with dolphin", $T_b = 0.534$, $p = 0.041$ (see Figure 12).

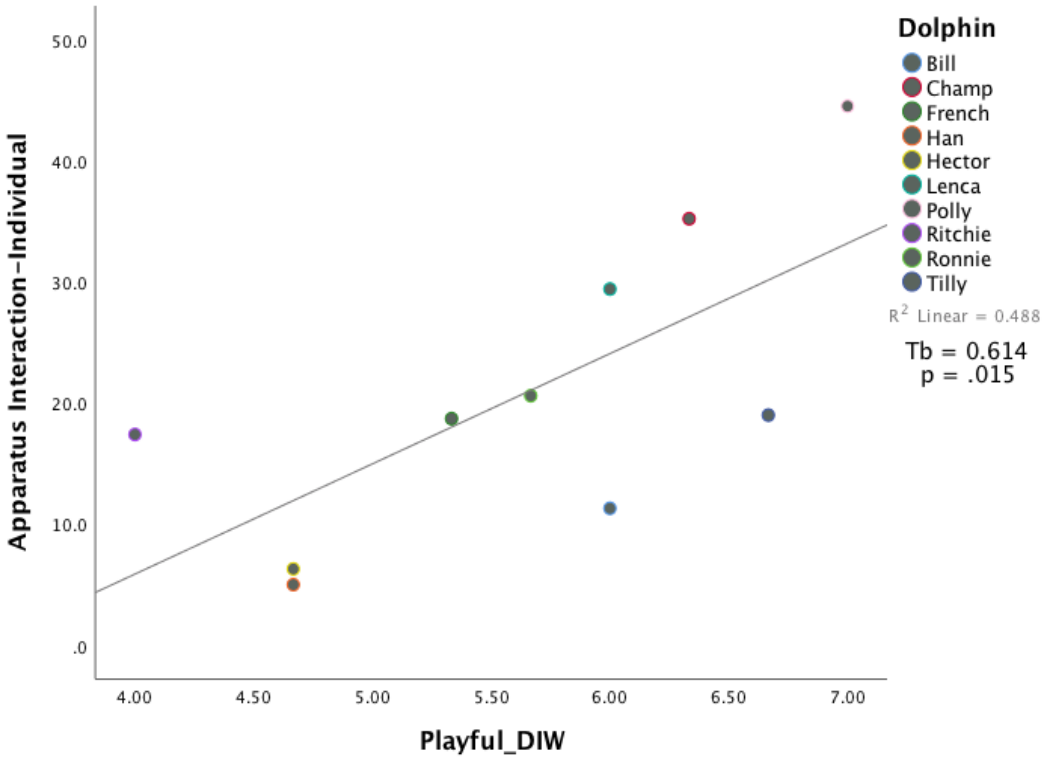

Figure 7

Scatterplot showing the strength of relationship between individual interactions with the apparatus and the trait playfulness in the context of
"dolphin interacts with physical world"

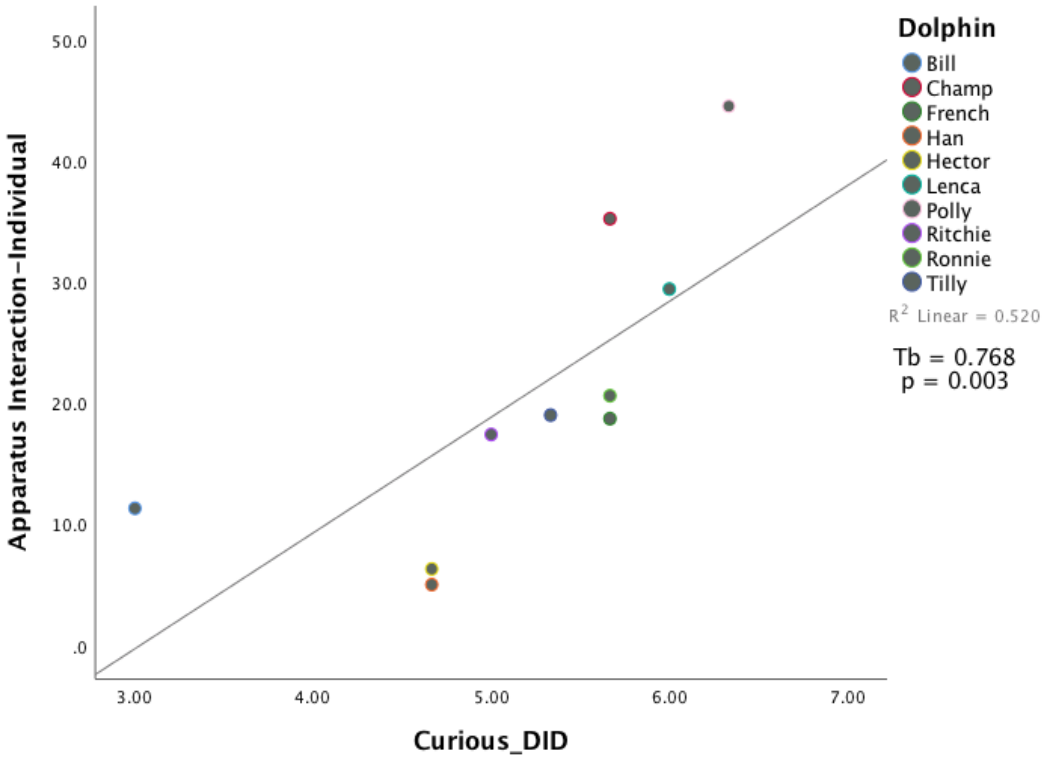

Figure 8

Scatterplot showing the strength of relationship between individual interactions with the apparatus and the trait “curiosity” in the context of “dolphin interacts with dolphin”

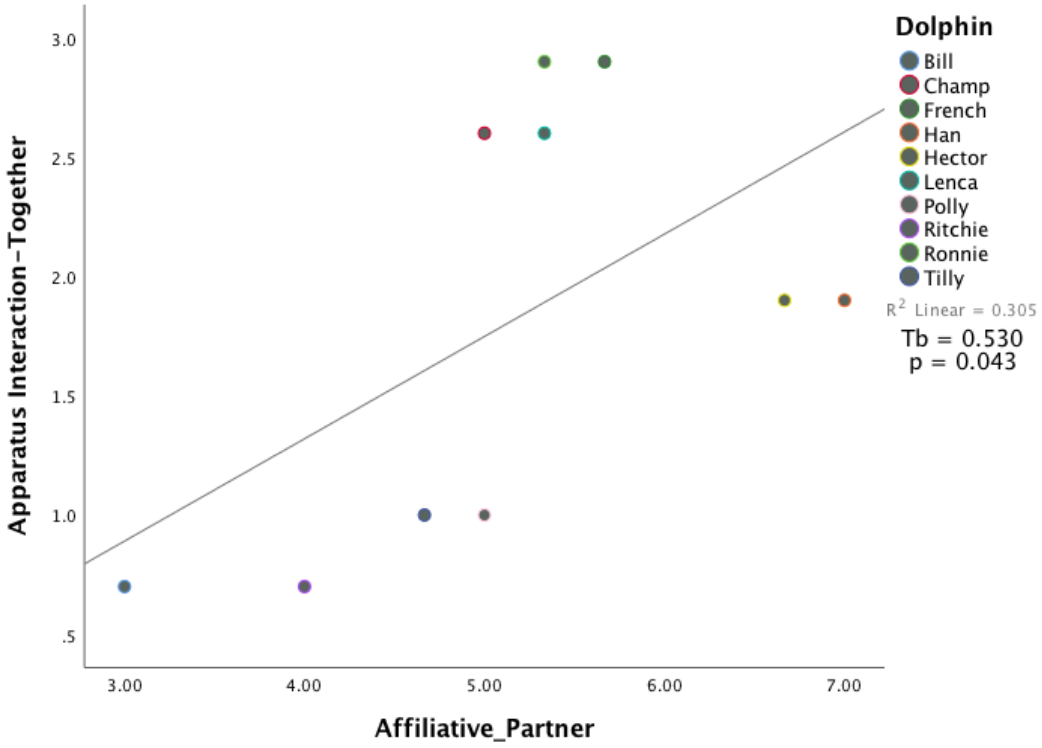

Figure 9

Scatterplot showing the strength of relationship between “paired interactions with the apparatus” and “affiliativeness” with his/her partner

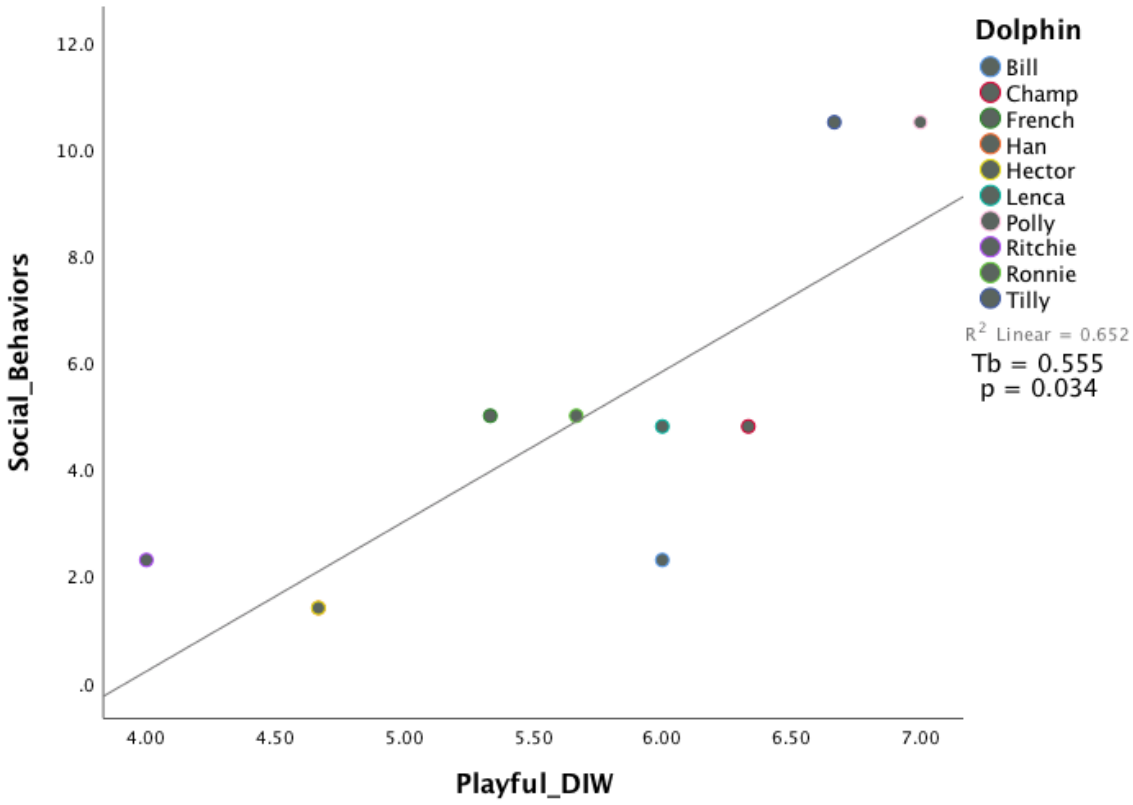

Figure 10

Scatterplot showing the strength of relationship between “social” and “playfulness” in the context of “dolphin interacts with physical world”

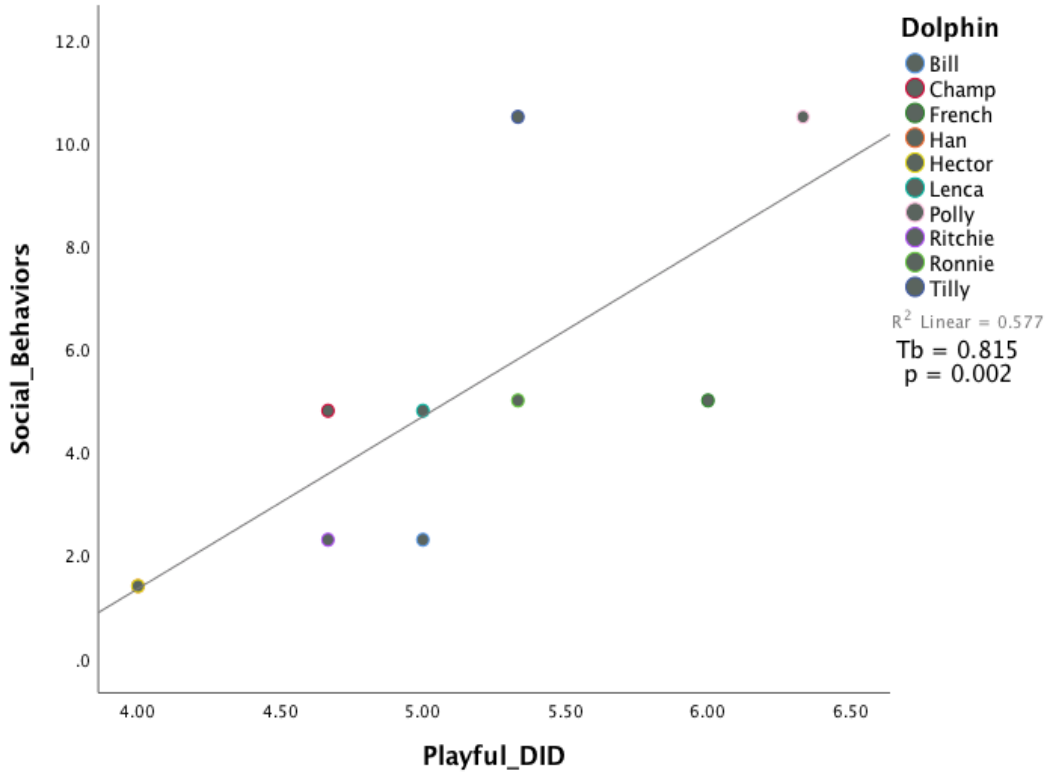

Figure 11

Scatterplot showing the strength of relationship between “social” and “playfulness” in the context of “dolphin interacts with dolphin”

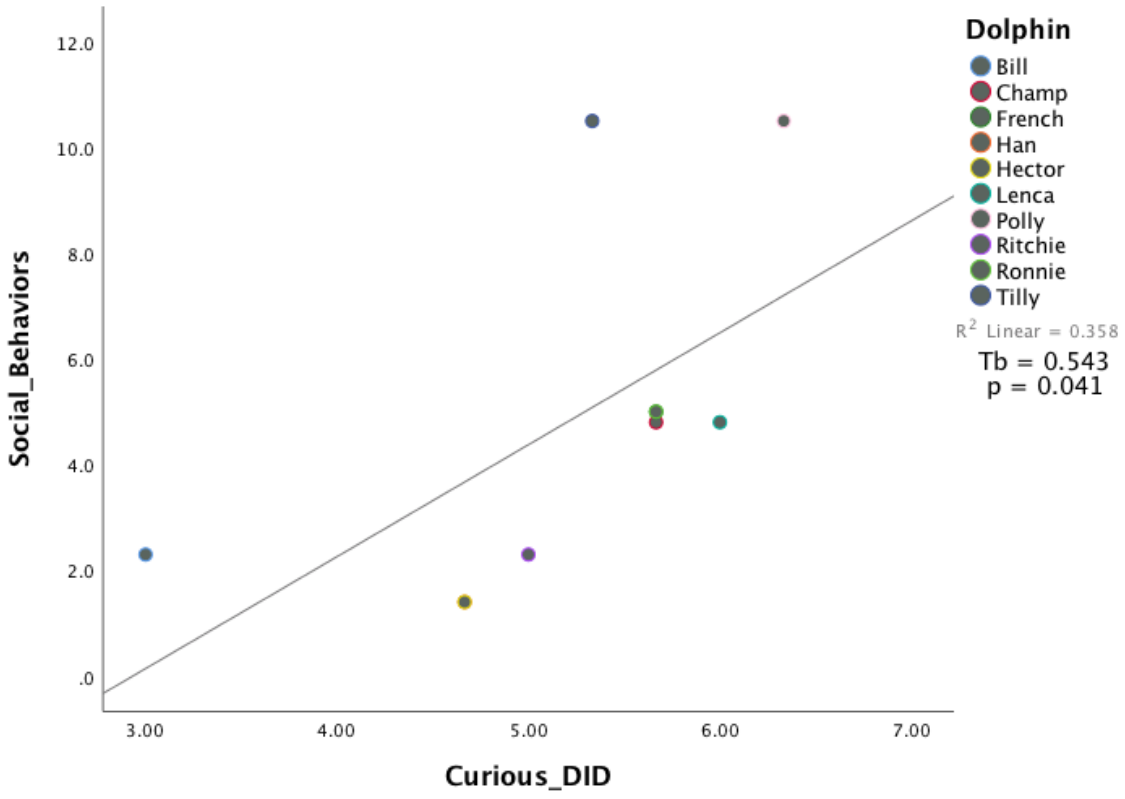

Figure 12

Scatterplot showing the strength of relationship between "social" and "curiosity" in the context of "dolphin interacts with dolphin"

All personality traits were aggregated into the five factor personality domains: openness, conscientiousness, extraversion, agreeableness, and neuroticism. Comparisons of these five domains to the three behavior categories showed two significant correlation: "openness to experience" was positively related to "individual interactions with the apparatus", $T_b = 0.644$, $p = 0.009$ (see Figure 13); "agreeableness" was positively correlated with "paired interactions with the apparatus", $T_b = 0.530$, $p = 0.043$ (see Figure 14). I made a further comparison by only aggregating only the three traits in that both the ICC_2 and Kendall's W found significant agreement: "playfulness" in the context of "dolphin interacts with physical world", "aggressive", and "affiliative". These traits corresponded with "extraversion", "agreeableness", and

"neuroticism". This analysis showed positive correlations between "extraversion" and "individual interactions with the apparatus", $T_b = 0.614$, $p = 0.015$ (see Figure 15); "social" behaviors and "extraversion", $T_b = 0.555$, $p = 0.034$ (see Figure 16); and between "agreeableness" and "paired interactions with apparatus", $T_b = 0.530$, $p = 0.043$ (see Figure 17).

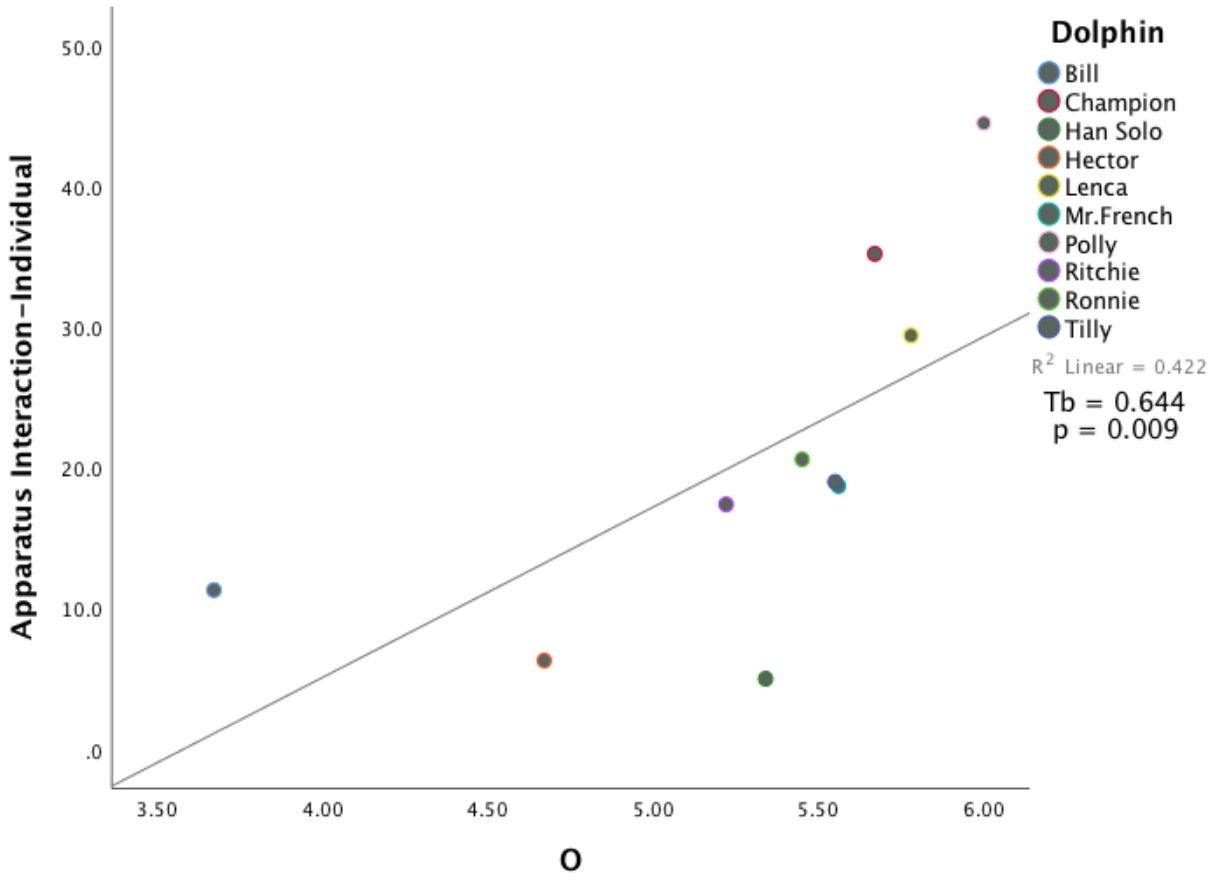

Figure 13

Scatterplot showing the strength of relationship between “individual interactions with the apparatus” and “openness to experience”

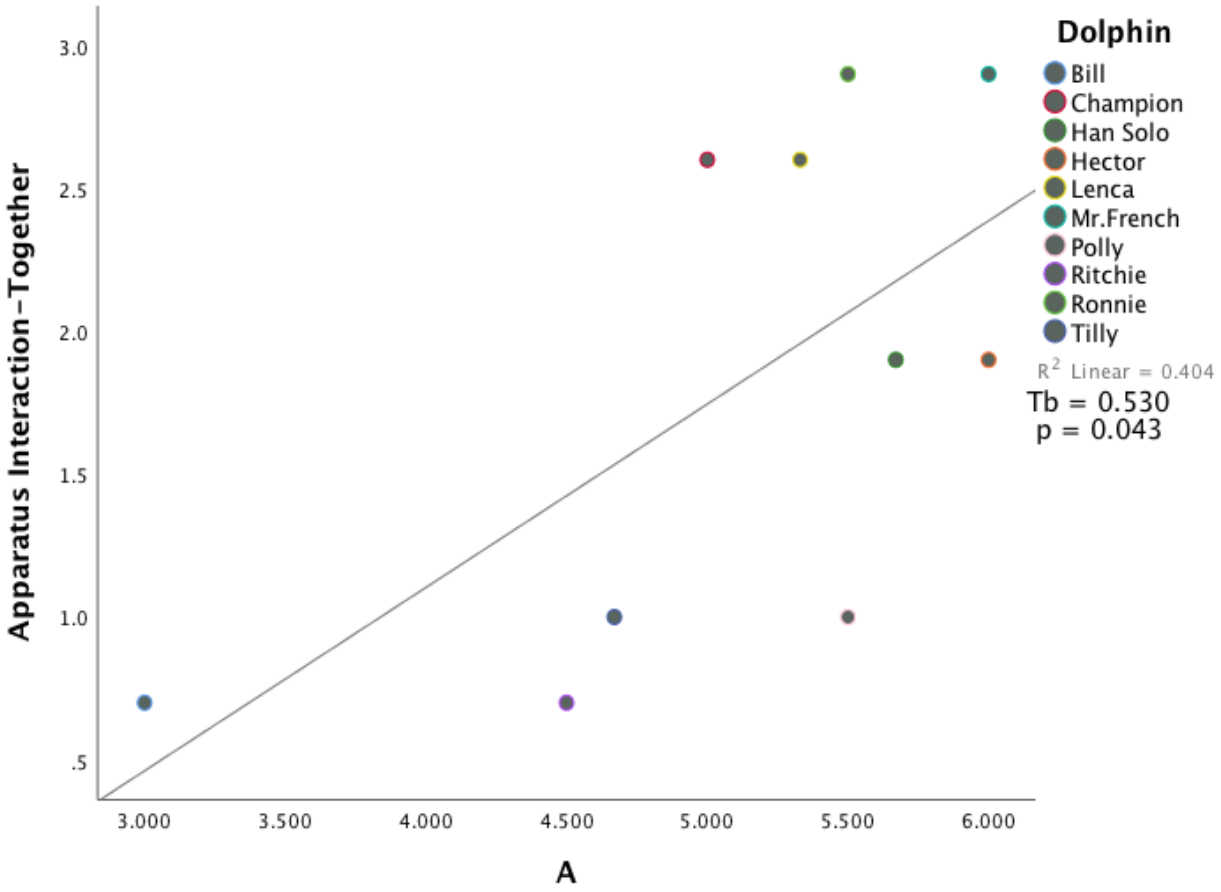

Figure 14

Scatterplot showing the strength of relationship between
"paired interactions with the apparatus" and "agreeableness"

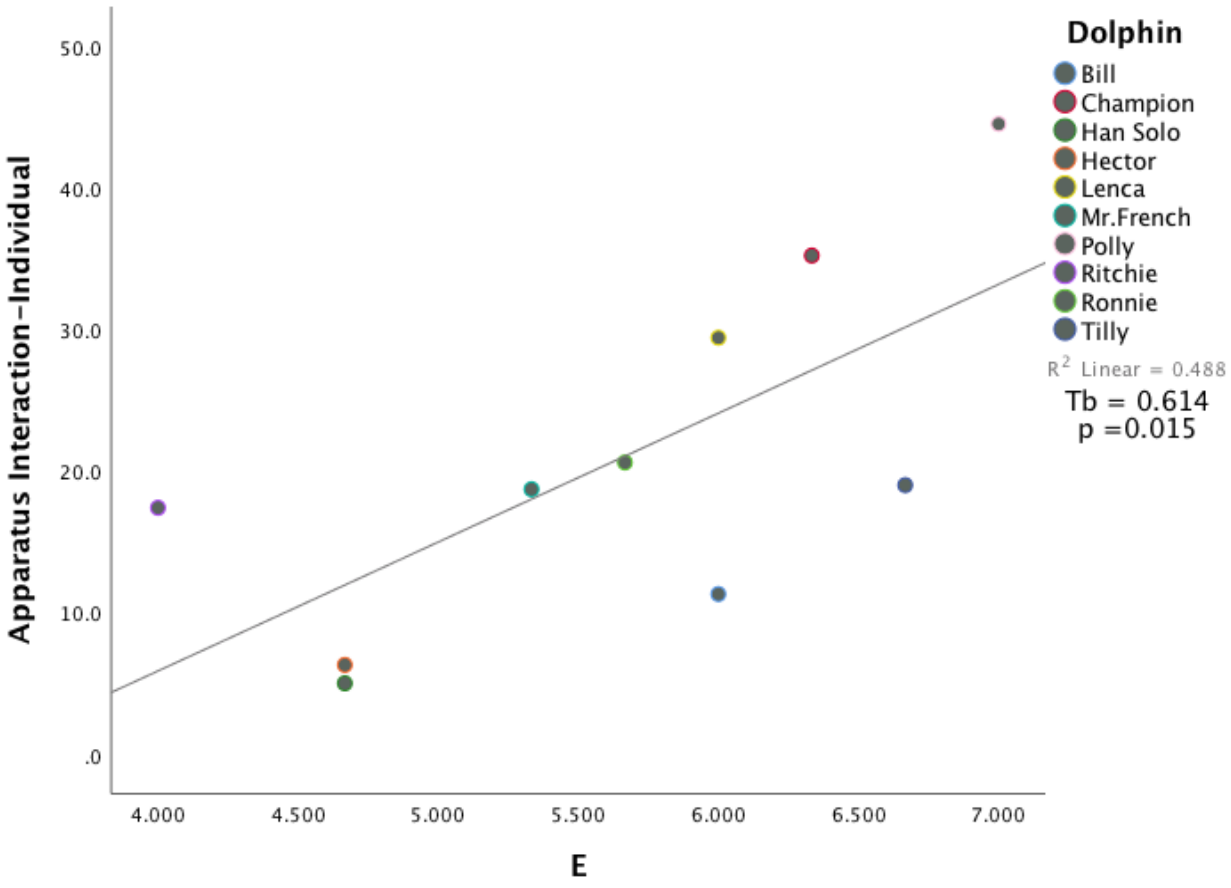

Figure 15

Scatterplot showing the strength of relationship
"individual interactions with the apparatus" and "extraversion"

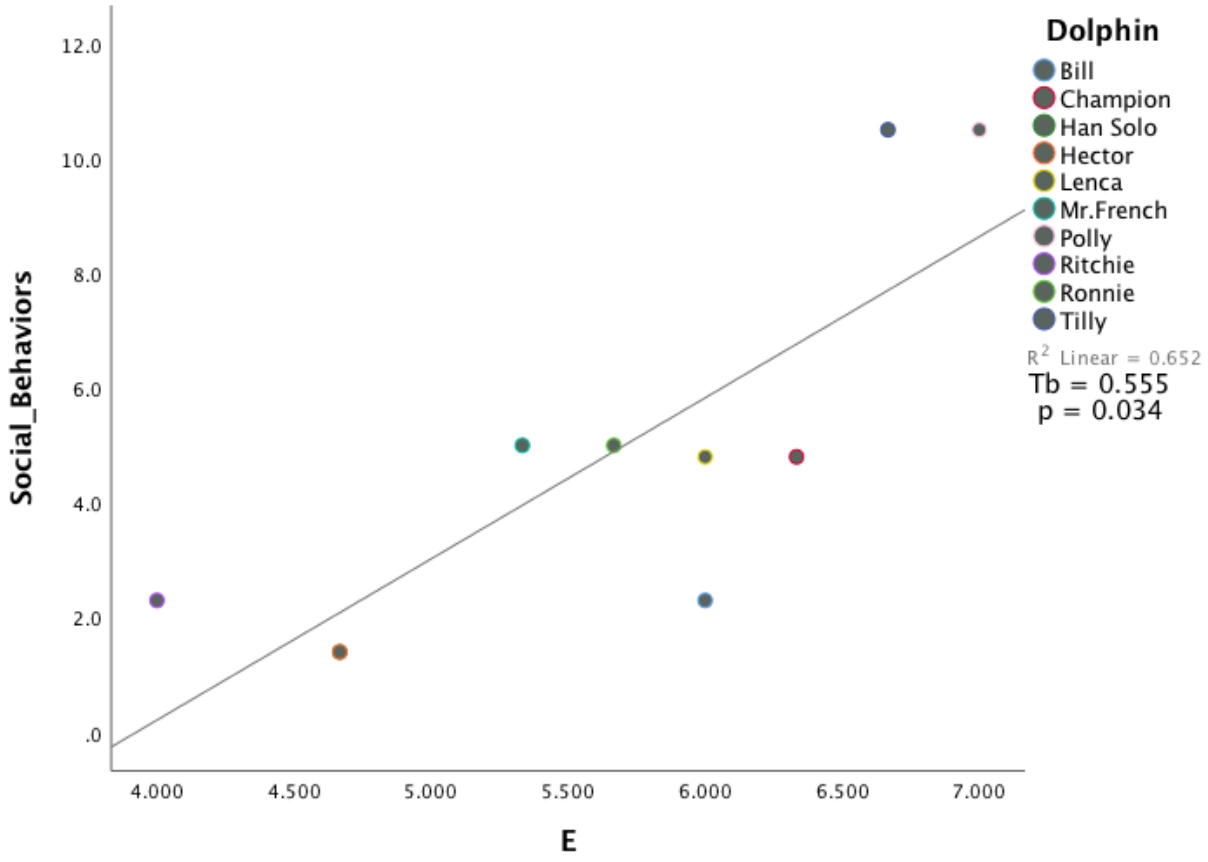

Figure 16

Scatterplot showing the strength of relationship “social” behaviors and “extraversion”

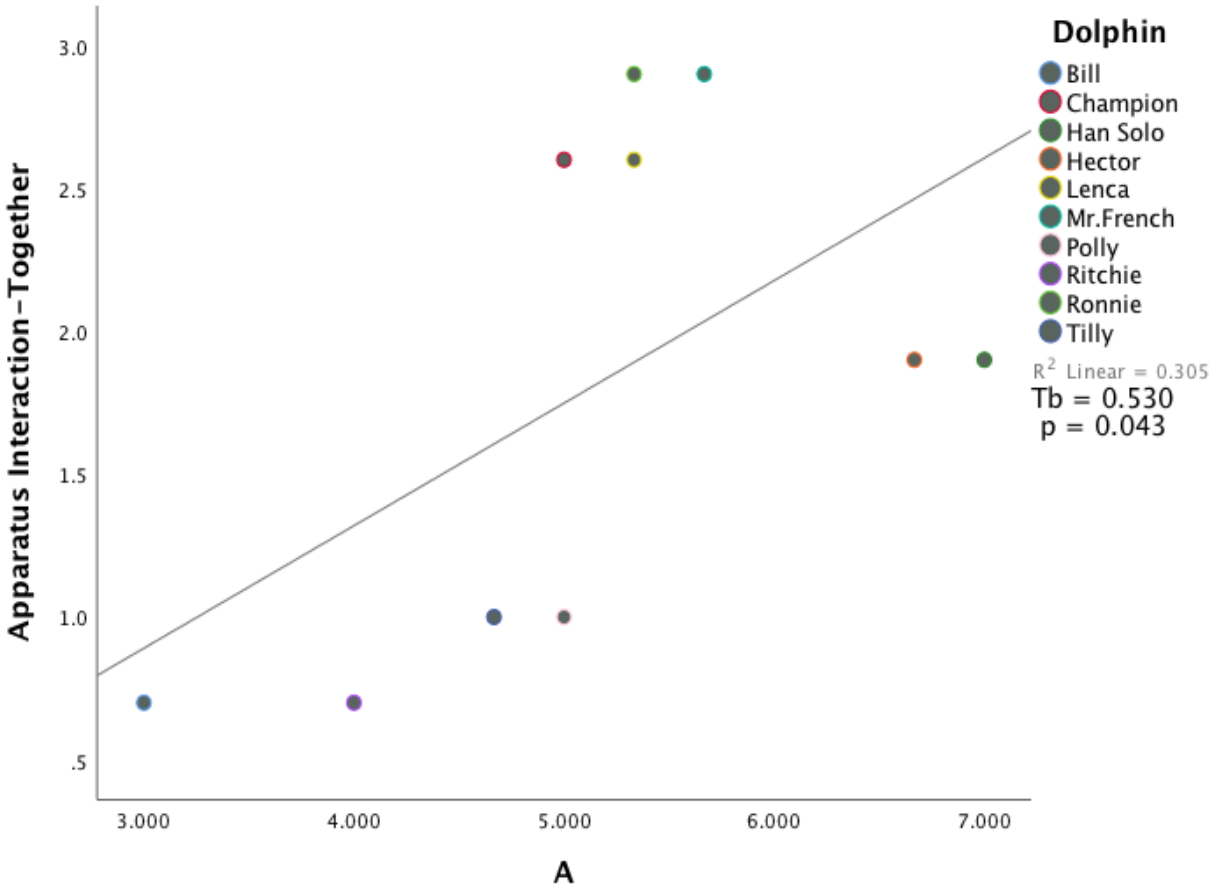

Figure 17

Scatterplot showing the strength of relationship
"paired interactions with the apparatus" and "agreeableness"

CHAPTER 4

DISCUSSION

None of the dolphin dyads succeeded in solving the problem by pulling open the apparatus and obtaining the fish. I instead analyzed behaviors that could be precursors to social problem solving. The correlation results showed several relationships between personalities and behaviors. First, the more playful a dolphin is with the physical world the more likely he/she is to interact with the apparatus in their enclosure. Highly affiliative pairs have the highest frequency of "paired interactions with the apparatus" suggesting that pairs that have a predisposition to socialize together might approach objects in their physical world together. Dolphins who engaged in social behaviors with their partner were playful with physical objects and other dolphins as well as curious about other dolphins. There was a relationship between "individual interaction with the apparatus" and curiosity about other dolphins, but not curiosity about the physical world. If a dolphin were extremely curious about other individuals, I would reason that dolphins would be preoccupied with other conspecifics and would show less interest in the apparatus. One possible explanation is stimulus enhancement stimulated by the other individual. There is evidence that expression of personalities is affected by others in social situations (Webster & Ward, 2011). It could be that the individual that is more curious about other dolphins over objects may not have be interested in the apparatus until the other individual in the enclosure interacted with it. Thus, the curiosity about the other dolphin's interaction spurs the observing individual to also interact with the apparatus.

When aggregating all traits into the five factor dimensions, the results showed individuals who interacted more with the apparatus were higher in their ratings of openness to experience. This shows that dolphins who are more willing to accept new experiences are more likely to interact with a novel object. Further, pairs who interacted with the apparatus together ranked higher in agreeableness. This finding suggests that the more sociable individuals are more likely to coordinate behavior with a partner when interacting with a new object. Aggregating only the three traits with high inter-judge agreement yielded additional relationships: the dolphins with a higher frequency of individual interactions with the apparatus were more extraverted; the more extraverted dolphins also participated in social behaviors with their partner. Extraverted individuals tend to find enjoyment and fulfillment and things outside of themselves and explains why these individuals would have interacted more with each other and the apparatus (Lucas, Diener, Grob, Suh, & Shao, 2000).

Results show that there are significant relationships between personality traits and affiliative behaviors in bottlenose dolphins. Another original aim of this study was to compare behaviors among pairs who are of similar ranking in personalities with behaviors among pairs who have different rankings in personalities; however, when looking at the traits that significantly correlated with behaviors, none of the pairs contained individuals who varied enough in ratings to warrant further analysis. In order to determine if a different dyad composition would have resulted in pairs with different personalities, a pseudo-couple analysis was conducted. The analysis showed that none of the possible pairing of dolphins would have significantly differed from the dyads that were used in their level of personality similarity thereby preventing any comparison of interactions between similar personalities and interactions between dissimilar personalities. This means that any dyads I could have created would have not

have had significantly different combination of personalities from the pairs that were used. A possible explanation is that the facility only pairs those dolphins who have similar personalities because they work best together.

Interrater reliability of the raters' assessment of personality analyses using both parametric and non-parametric statistical techniques showed similar results. Only one dolphin, Bill, did not have interrater reliability among all three judges. Reliability of Bills raters was tested again with all possible combinations of two raters and again none had a $W \geq .8$. Rather than average three largely varying scores for each trait, Bill's personality profiles were based solely on the ratings of Teri Bolton who has the longest relationship with him. The inter-judge agreement tests allowed for an interesting comparison of statistical strategies. ICC (2,1) scores are a reliability measurement meaning that it reports the level of variance in individual responses and rWG scores measure agreement in that it estimates the within-group agreement to determine if individual scores can be aggregated; both are typically considered acceptable when the values are $\geq .7$ (Cohen, Doveh, & Eick, 2001; Shrout & Fleiss, 1979). There were three traits that had high reliability and agreement values across all values: affiliative, aggressive, and playful in the context of dolphin interacts with physical world. There were some inconsistencies between ICC (2,1) and rWG scores. For example, the trait "observant" in the context of dolphin interacts with dolphin had an extremely low reliability score of -.627 but a high agreement score of .842. A possible explanation for this is the ICC (2,1) score may be skewed by the low sample size of ten. Although rWG is also a parametric measure and therefore susceptible to sample size, it is affected less than ICC (2,1) scores and is therefore a more dependable parametric measure for this study (Cohen et al., 2001). Further, non-parametric measures are the ideal statistical strategy when working with low sample sizes. Unlike parametric counterparts, these tests are not based

on the assumption that the sample is pulled from a normally distributed population (Siegal, 1956). My sample size of ten subjects came from a very small population of twenty dolphins who have very specific experiences and lives that set them apart from the more general population of "all bottlenose dolphins". This is an important factor to be taken into account and dictates that the non-parametric Kendall's W is the most reliable measure of inter-judge agreement.

When designing this experiment, the aim was to study cooperative problem-solving with the apparatus; however, none of the dolphin dyads successfully opened it. There are a few possible reasons why this did not occur and does not suggest that the dolphins did not possess the capabilities to solve the problem. Sessions were scheduled to run for four weeks; however, social dynamics and reproductive cycles resulted in a delay of data collection. Due to the novelty of the object, training staff encouraged the animals to interact via training sessions to prevent neophobia. We supplemented our lost sessions with exposure and training sessions with certain individuals that did move to the back pens during the first week. None of the dolphins were taught how to open the apparatus cooperatively; the sessions focused on acclimating the dolphins to the apparatus floating near his/her face as well as teaching them to hold and pull the rope individually.

The greatest possible confound that might have affected the dolphins' failure to open the apparatus comes from the procedure of dumping the contents immediately before and after each trial. The opening of the apparatus and the expulsion of the fish preceding the trials was similar to the exposure trial used in Kuczaj et al. (2015) and served to show the subjects that there was food inside the tube and how it could be accessed. The dolphins in the Kuczaj et al. (2015) study only received the reinforcement from the task if they were successful. Conversely, the

management staff at RIMS decided the animals should receive the reinforcement at the end of the trial, regardless of the result to prevent any teasing of the animals. This reinforcement might have taught the subjects that a food reward would be gained whether they opened it themselves or not; therefore, the dolphins' may not have been properly motivated as the food would be given to them regardless of their participation.

None of the dolphins in this study successfully opened the apparatus, but it is possible as shown in Kuczaj et al. (2015). The dolphins used in the 2015 study were regularly exposed to non-natural environmental enrichment such as toys while the RIMS dolphins rarely receive any stimulus that cannot be found naturally in their enclosure. It is possible that this previous exposure to similar stimulus made the dolphins from the 2015 study more willing to interact with the apparatus (K. Winship, personal communication). An additional argument for the cooperative aspect of this research comes from King et al. (2016) who reasoned that the task is more competitive than cooperative because it requires force to be applied in opposite directions. Previous rope-pulling tasks required force to be applied in the same direction. This is a valid argument; however, the pair that successfully opened the apparatus in Kuczaj et al. (2015) were observed sharing the food with each other which suggests that the task was cooperative. King et al. (2016) also stated that this task might not be cooperative because it requires the animals to act in opposite directions which is not seen in other cooperation experiments; however, such cooperation has been noted by wild bottlenose dolphins. Wild bottlenose dolphins have been known to herd fish which sometimes requires them to approach each other from opposite directions showing that cooperation does not always require movement in the same direction (Gazda et al., 2005)

There are several avenues for future research following this study. First, this cooperative problem-solving task should be given to a larger sample of paired individuals. Additionally, this apparatus should be exposed to a wider variety of bottlenose dolphins for a longer period of time. One pair did successfully solve the problem in the original study by Kuczaj et al. (2015) which shows that this species does have the capability to succeed in this task. Other future studies could continue to examine the relationships between social behaviors and personalities.

Although the dolphins did not cooperate to open the apparatus, the interactive and affiliative behaviors analyzed may be precursors to cooperation. My research provides valuable information on how personalities can predict affiliative and interactive behaviors in Bottlenose dolphins. The results suggest that animals that rate high in specific aspects of personality tend to be more affiliative and interactive and could be used when preparing to pair animals together or to expose them to enrichment items. Living a successful and healthy life is dependent on an individual being able to appropriately interact with the situations an environment will produce. Behavioral tendencies that arise from personalities are important in understanding how an individual is going to experience and interact with the world around him or her. They are perhaps even more important for species that live social lives as individuals are not only affected by the physical environment, but also by their conspecifics.

REFERENCES

Altmann, J. (1974). Observational study of behavior: Sampling methods. *Behaviour, 49*(3), 227-266.

Aplin, L. M., Farine, D. R., Mann, R. P., & Sheldon, B. C. (2014). Individual-level personality influences social foraging and collective behaviour in wild birds. *Proceedings of the Royal Society of London B: Biological Sciences, 281*(1789), 20141016.

Bednarz, J. C. (1988). Cooperative hunting in Harris' hawks (*Parabuteo unicinctus*). *Science, 239*(4847), 1525.

Bergmüller, R., Schürch, R., & Hamilton, I. M. (2010). Evolutionary causes and consequences of consistent individual variation in cooperative behaviour. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 365*(1553), 2751-2764.

Bergmüller, R., & Taborsky, M. (2010). Animal personality due to social niche specialisation. *Trends in ecology & evolution, 25*(9), 504-511.

Boesch, C., & Boesch, H. (1989). Hunting behavior of wild chimpanzees in the Tai National Park. *American Journal of Physical Anthropology, 78*(4), 547-573.

Carere, C., & Locurto, C. (2011). Interaction between animal personality and animal cognition. *Current Zoology, 57*(4), 491-498.

Chalmeau, R., Lardeux, K., Brandibas, P., & Gallo, A. (1997). Cooperative problem solving by orangutans (*Pongo pygmaeus*). *International Journal of Primatology, 18*(1), 23-32.

Cohen, A., Doveh, E., & Eick, U. (2001). Statistical properties of the rWG (J) index of agreement. *Psychological Methods, 6*(3), 297.

Connor, R. C. (2010). Cooperation beyond the dyad: on simple models and a complex society. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 365*(1553), 2687-2697.

Connor, R. C., Smolker, R. A., & Richards, A. F. (1992). Two levels of alliance formation among male bottlenose dolphins (*Tursiops sp.*). *Proceedings of the National Academy of Sciences, 89*(3), 987-990.

Dall, S. R. X., Houston, A. I., & McNamara, J. M. (2004). The behavioural ecology of personality: consistent individual differences from an adaptive perspective. *Ecology Letters, 7*(8), 734-739. doi:10.1111/j.1461-0248.2004.00618.x

Drea, C. M., & Carter, A. N. (2009). Cooperative problem solving in a social carnivore. *Animal Behaviour, 78*(4), 967-977. doi:10.1016/j.anbehav.2009.06.030

Duffy-Echevarria, E. E., Connor, R. C., & St Aubin, D. J. (2008). Observations of strand-feeding behavior by bottlenose dolphins (Tursiops truncatus) in Bull Creek, South Carolina. *Marine Mammal Science, 24*(1), 202-206.

English, S., Nakagawa, S., & Clutton-Brock, T. H. (2010). Consistent individual differences in cooperative behaviour in meerkats (*Suricata suricatta*). *Journal of evolutionary biology, 23*(8), 1597-1604. doi:10.1111/j.1420-9101.2010.02025.x

Fewell, J. H. (2003). Social insect networks. *Science, 301*(5641), 1867-1870.

Friard, O., & Gamba, M. (2016). BORIS: Behavioral Observation Research Interactive Software (Version 4.1.3).

Gabriel, P. O., & Black, J. M. (2012). Behavioural syndromes, partner compatibility and reproductive performance in Steller's jays. *Ethology, 118*(1), 76-86.

Gazda, S. K., Connor, R. C., Edgar, R. K., & Cox, F. (2005). A division of labour with role specialization in group–hunting bottlenose dolphins (*Tursiops truncatus*) off Cedar Key, Florida. *Proceedings of the Royal Society of London B: Biological Sciences, 272*(1559), 135-140.

Gosling, S. D. (2008). Personality in non-human animals. *Social and Personality Psychology Compass, 2*(2), 985-1001.

Hall, R. H., Rocklin, T. R., Dansereau, D. F., Skaggs, L. P., O'donnell, A. M., Lambiotte, J. G., & Young, M. D. (1988). The role of individual differences in the cooperative learning of technical material. *Journal of Educational psychology, 80*(2), 172.

Hattori, Y., Kuroshima, H., & Fujita, K. (2005). Cooperative problem solving by tufted capuchin monkeys (*Cebus apella*): spontaneous division of labor, communication, and reciprocal altruism. *Journal of Comparative Psychology, 119*(3), 335.

Highfill, L. E., & Kuczaj II, S. A. (2007). Do bottlenose dolphins (Tursiops truncatus) have distinct and stable personalities? *Aquatic Mammals, 33*(3), 380.

Highfill, L. E., & Kuczaj, S. A. (2010). How studies of wild and captive dolphins contribute to our understanding of individual differences and personality. *International Journal of Comparative Psychology, 23*(3).

King, S. L., Allen, S. J., Connor, R. C., & Jaakkola, K. (2016). Cooperation or dolphin 'tug-of-war'? Comment on Kuczaj et al. and Eskelinen et al. *Animal Cognition, 19*(6), 1227-1229. doi:10.1007/s10071-016-1026-x

Kuczaj, Highfill, & Byerly. (2012). The importance of considering context in the assessment of personality characteristics: evidence from ratings of dolphin personality. *International Journal of Comparative Psychology, 25*(4).

Kuczaj, Winship, K. A., & Eskelinen, H. C. (2015). Can bottlenose dolphins (*Tursiops truncatus*) cooperate when solving a novel task? *Animal Cognition, 18*(2), 543-550. doi:10.1007/s10071-014-0822-4

Lewis, J., & Schroeder, W. (2003). Mud plume feeding, a unique foraging behavior of the bottlenose dolphin in the Florida Keys. *Gulf of Mexico Science, 21*(1), 92-97.

Łopuch, S., & Popik, P. (2011). Cooperative behavior of laboratory rats (*Rattus norvegicus*) in an instrumental task. *Journal of Comparative Psychology, 125*(2), 250.

Louis, M., Viricel, A., Lucas, T., Peltier, H., Alfonsi, E., Berrow, S., . . . Deaville, R. (2014). Habitat-driven population structure of bottlenose dolphins, Tursiops truncatus, in the North-East Atlantic. *Molecular Ecology, 23*(4), 857-874.

Lucas, R. E., Diener, E., Grob, A., Suh, E. M., & Shao, L. (2000). Cross-cultural evidence for the fundamental features of extraversion. *Journal of personality and social psychology, 79*(3), 452.

McNamara, J. M., & Leimar, O. (2010). Variation and the response to variation as a basis for successful cooperation. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 365*(1553), 2627-2633.

Moreno, K. R. (2017). *Does Personality Similarity in Bottlenose Dolphin Pairs Influence Dyadic Bond Characteristics?* (Masters of Arts), The University of Southern Mississippi.

Péron, F., Rat-Fischer, L., Lalot, M., Nagle, L., & Bovet, D. (2011). Cooperative problem solving in African grey parrots (*Psittacus erithacus*). *Animal Cognition, 14*(4), 545-553.

Petricig, R. O. (1995). *Bottlenose dolphins (Tursiops truncatus) in Bull Creek, South Carolina.* University of Rhode Island.

Plotnik, J. M., Lair, R., Suphachoksahakun, W., & De Waal, F. B. (2011). Elephants know when they need a helping trunk in a cooperative task. *Proceedings of the National Academy of Sciences, 108*(12), 5116-5121.

Qualtrics, I. (2013). Qualtrics.com.

Réale, D., Reader, S. M., Sol, D., McDougall, P. T., & Dingemanse, N. J. (2007). Integrating animal temperament within ecology and evolution. *Biological reviews, 82*(2), 291-318.

Seed, A. M., Clayton, N. S., & Emery, N. J. (2008). Cooperative problem solving in rooks (*Corvus frugilegus*). *Proceedings of the Royal Society of London B: Biological Sciences, 275*(1641), 1421-1429.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: uses in assessing rater reliability. *Psychological bulletin, 86*(2), 420.

Siegal, S. (1956). *Nonparametric statistics for the behavioral sciences*: McGraw-hill.

Sih, A., Bell, A., & Johnson, J. C. (2004). Behavioral syndromes: an ecological and evolutionary overview. *Trends in ecology & evolution, 19*(7), 372-378.

Sih, A., & Bell, A. M. (2008). Insights for behavioral ecology from behavioral syndromes. *Advances in the Study of Behavior, 38*, 227-281.

Snowdon, C. T., & Cronin, K. A. (2007). Cooperative breeders do cooperate. *Behavioural Processes, 76*(2), 138.

Uher, J. (2008). Comparative personality research: methodological approaches. *European Journal of Personality, 22*(5), 427-455.

Verbeek, M. E., Drent, P. J., & Wiepkema, P. R. (1994). Consistent individual differences in early exploratory behaviour of male great tits. *Animal Behaviour, 48*(5), 1113-1121.

Visser, I. N., Smith, T. G., Bullock, I. D., Green, G. D., Carlsson, O. G., & Imberti, S. (2008). Antarctic peninsula killer whales (*Orcinus orca*) hunt seals and a penguin on floating ice. *Marine Mammal Science, 24*(1), 225-234.

Webster, M. M., & Ward, A. J. (2011). Personality and social context. *Biological reviews, 86*(4), 759-773.

Wolf, M., & Weissing, F. J. (2012). Animal personalities: consequences for ecology and evolution. *Trends in ecology & evolution, 27*(8), 452-461.

APPENDIX A

IACUC APPROVAL FORMS

THE UNIVERSITY of TENNESSEE CHATTANOOGA

Institutional Animal Care and Use Committee
Dept. 4915
615 McCallie Avenue
Chattanooga, TN 37403-2598
Phone: (423) 425-5867
Fax: (423) 425-4052
iacucpro@utc.edu
http://www.utc.edu/iacuc

MEMORANDUM

TO: Kimberly Bagley
Preston Foerder

FROM: Dr. Ethan Carver, IACUC Chair
Lindsay Pardue, Director of Research Integrity

DATE: July 20, 2017

SUBJECT: **IACUC #: 17-04:** Dolphin Personality/Cooperation

The UTC Institutional Animal Care and Use Committee has reviewed and approved your application and assigned you the IACUC number listed above.

Reminder: Approved protocols must be reviewed at least annually. It is the responsibility of the principal investigator to submit an Application for Protocol Annual Continuation form to the IACUC before the anniversary date of the approved protocol. However, the Office of Research Integrity shall make every effort to send reminders 30 days prior to the anniversary date. The annual review form must be completed and submitted to the IACUC Committee before the first day of the anniversary month. New protocols must be submitted and approved every three years.

Please remember to submit a Protocol Modification Form if significant changes occur in your research design or in any instruments used in conducting the study. You should also contact the IACUC immediately if you encounter any adverse effects during your protocol.

For additional information, please consult our webpage http://www.utc.edu/iacuc or email iacucpro@utc.edu.

Best wishes for a successful research project.

THE UNIVERSITY of TENNESSEE CHATTANOOGA

Institutional Animal Care and Use Committee
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Chattanooga, TN 37403-2598
Phone: (423) 425-5867
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http://www.utc.edu/iacuc

MEMORANDUM

TO: Dr. Preston Foerder
Ms. Kimberly Bagley

FROM: Dr. Ethan Carver, Chair, Institutional Animal Care and Use Committee

DATE: 08/10/2017

SUBJECT: **IACUC #: 17-04: Dolphin Personality/Cooperation**

The UTC Institutional Animal Care and Use Committee has reviewed and approved the modifications requested on 08/04/2017 for the IACUC number listed above.

- ☐ There will be an increase in the number of an already approved species.
- ☐ Changing an approved procedure.

For additional information, please consult our webpage http://www.utc.edu/iacuc or email iacucpro@utc.edu.

Best wishes for a successful research project.

APPENDIX B

DOLPHIN PERSONALITY SCALE

RIMS Dolphin Personality Survey (Kuczaj, Highfill, & Byerly, 2012)

Dolphin Personality Scale

Dolphin Name: _____

Rater: _____

Facility: _____

Date: _____

Please note that this questionnaire is divided into two sections with individual instructions for each. Please follow the instructions carefully for each section. Thank you!

General instructions: In each section, you will be asked to rate this dolphin in terms of a list of adjectives. Please indicate the answer that you think best describes this dolphin for each set of adjectives.

If you are unable to make a judgment about a particular adjective, please write "DK" to signify "don't know" next to the adjectives.

Please do not discuss this survey with any of the other participants in this study. This will help ensure the most object data from each individual.

thanks for your help with evaluating dolphin personalities!

Example: If the dolphin is viewed as slightly not cooperative, then

"slightly not cooperative" would be indicated.

Cooperative <---1--------2----------3----------4----------5----------6----------7->Not Cooperative

Extremely Cooperative	quite cooperative	slightly cooperative	Neutral	slightly not cooperative	quite not cooperative	extremely not cooperative

SECTION I: Interactions with Physical World

For this section, we are concerned with how dolphins interact with their physical environment, including objects. Interactions with other dolphins should NOT be considered in this section. So please rate this dolphin on each of the following adjectives based on how the dolphin deals with its physical environment.

Curious <------1----------2----------3--------4----------5----------6----------7----> Not Curious

Extremely curious quite curious slightly curious Neutral slightly not curious quite not curious extremely not curious

Confident <-----1---------2----------3----------4----------5----------6----------7-->Not Confident

Extremely confident quite confident slightly confident Neutral slightly not confident quite not confident extremely not confident

Observant <---1----------2----------3----------4----------5----------6----------7-->Not Observant

Extremely observant quite Observant slightly Observant Neutral slightly not observant quite not observant extremely not observant

Playful <---1--------2----------3--------4----------5----------6----------7-->Not Playful

Extremely playful quite playful slightly playful Neutral slightly not playful quite not playful extremely not playful

Creative <---1--------2----------3---------4----------5----------6----------7-->Not Creative

Extremely creative quite creative slightly creative Neutral slightly not creative quite not creative extremely not creative

Timid <---1--------2----------3----------4----------5----------6----------7---->Bold

Extremely timid quite timid slightly timid Neutral slightly bold quite bold extremely bold

SECTION II: Interactions with Other Dolphins

For this section, we are concerned with how dolphins behave towards other dolphins. Please rate this dolphin on each of the following adjectives based on how the dolphin interacts with other dolphins.

Playful <---1--------2----------3---------4----------5----------6----------7-->Not Playful

Extremely playful	quite playful	slightly playful	Neutral	slightly not playful	quite not playful	extremely not playful

Observant <---1---------2----------3----------4----------5----------6----------7-->Not Observant

Extremely observant	quite Observant	slightly Observant	Neutral	slightly not observant	quite not observant	extremely not observant

Tolerant <---1----------2----------3----------4----------5----------6----------7--->Not Tolerant

Extremely tolerant	quite tolerant	slightly tolerant	Neutral	slightly not tolerant	quite not tolerant	extremely not tolerant

Solitary <---1--------2----------3----------4----------5----------6----------7---->Not Solitary

Extremely solitary	quite solitary	slightly solitary	Neutral	slightly not solitary	quite not solitary	extremely not solitary

Dominant <---1----------2----------3----------4----------5----------6----------7-->Submissive

Extremely dominant	quite dominant	slightly dominant	Neutral	slightly submissive	quite submissive	extremely submissive

Curious <--------1--------2----------3----------4----------5----------6----------7-->Not Curious

Extremely curious	quite curious	slightly curious	Neutral	slightly not curious	quite not curious	extremely not curious

Aggressive <---1--------2----------3----------4----------5----------6----------7->Not Aggressive

Extremely Aggressive	quite aggressive	slightly aggressive	Neutral	slightly not aggressive	quite not aggressive	extremely not aggressive

Shy <---1--------2----------3----------4----------5---------6----------7--->Bold

Extremely shy	quite shy	slightly shy	Neutral	slightly bold	quite bold	extremely bold

Affiliative <---1----------2----------3----------4----------5----------6----------7---->Not Affiliative

Extremely Cooperative	quite cooperative	slightly cooperative	Neutral	slightly not cooperative	quite not cooperative	extremely not cooperative

Thanks again for your help! If you have any questions or comments after you complete this survey, please note them here:

APPENDIX C

ETHOGRAM

Behavioral Event	Definition	Category
Push	One dolphin makes forceful contact with apparatus	Individual Interaction
Bite	Dolphin uses teeth to apply force directly to apparatus or to rope attached to apparatus	Individual Interaction
Approach Apparatus	Dolphin make direct movement toward apparatus	Individual Interaction
Tug	Dolphin pulls on a rope connected to the apparatus	Individual Interaction
Contact	Dolphin makes direct physical contact with apparatus or rope	Individual Interaction
Orient to apparatus	Dolphin positions the head and body toward apparatus	Individual Interaction
Swim By	Dolphin swims past the apparatus a maximum of one body length away	Individual Interaction
Hit	Dolphin makes forceful contact with apparatus with the rostrum or fluke	Individual Interaction
Push Together	Both dolphins make forceful contact with apparatus	Paired Interaction
Bite Together	Both dolphins use teeth to apply force directly to apparatus or to rope attached to apparatus	Paired Interaction
Approach Apparatus Together	Both dolphins make direct movement toward apparatus	Paired Interaction
Contact Together	Both dolphins make direct physical contact with apparatus or rope	Paired Interaction
Orient to apparatus Together	Both dolphins position the head and body toward apparatus	Paired Interaction
Swim by Together	Both dolphins swim past the apparatus a maximum of one body length away	Paired Interaction
Approach Dolphin	Dolphin makes direct movement closer another dolphin	Social
Orient to dolphin	Dolphin positions the head and body towards another dolphin. Recipient of another dolphin bringing.	Social
Pair Swim	Dolphins are swimming in synchrony with a maximum of one body length away from each other	Social
Follow	One dolphin is following a maximum of one body length behind the other dolphin	Social

APPENDIX D

ADJECTIVES AND DEFINITIONS USED FOR DOLPHIN PERSONALITY MEASURE

Adjectives and definitions used for dolphin personality measure based on the human Five Factor Model (Kuczaj, Highfill, & Byerly, 2012)

Factor I: Openness to Experience	Factor II: Conscientiousness	Factor III: Extroversion	Factor IV: Agreeableness	Factor V: Neuroticism
(+) Creative, imaginative: Approaches situations and addresses problems in novel, creative ways (e.g., finds various ways to play with a toy).	(+) Careful, cautious: Animal exhibits care in its actions.	(+) Assertive: Self-assured, not easily intimidated.	(+) Friendly, gentle: Friendly, amicable, and congenial toward other animals and humans. Responds to others in an easy, kind manner. Not hostile. Not antagonistic.	(+) Jealous: Resentful or envious of another dolphin.
(+) Intelligent: Animal appears to learn easily. Quick to understand.	(+) Alert, vigilant: Ready, attentive, watchful; appears to pay attention to surroundings	(+) Playful: Engages in play behavior.	(+) Obedient, cooperative: Obeys; cooperates with instructions. Not defiant.	(+) Aggressive: Threatens or causes harm; high frequency of raking, biting, or hitting other animals and/or humans.
(+) Curious: Appears to be interested in new situations or objects.	(+) Diligent, attentive: Animal monitors its actions and exhibits a willingness to please.	(+) Active, energetic: Moves around a lot. Locomotion can include swimming, leaping, behaving, etc. Not lethargic.	(+) Affiliative, companionable: Agreeable and sociable. Appears to like the company of others. Seeks out social contact with another animals or person.	(+) Temperamental: Displays frequent mood swings.
(--) Not exploratory or inquisitive: Does not seek out or investigate novel situations or objects.	(--) Lazy: Resistant to work or exertion.	(--) Timid: Hesitant, apprehensive, tentative.	(--) Inflexible, incompliant: Stubborn or headstrong. Not willing to adapt or change.	(--) Relaxed, calm: Assured or at ease. Not tense or highly sensitive.

(--) Unoriginal, conforming: Not inventive or original; does not produce new and unusual actions.	(--) Undependable, unreliable: Not easily relied or depended on. Not a “go-to” animal.	(--) Quiet, not vocal: Does not vocalize often.	(--) Demanding: Requires much effort or attention from other dolphins and/or humans.	(--) Comfortable, complacent: Self- satisfied, content; appears free from anxiety.
(--) Simple: Engages in routine behaviors. Does not have a complex behavioral repertoire.	(--) Inconsistent, variable: Not consistent or predictable.	(--) Unexcitable: Not readily roused into action; relatively unresponsive to stimuli	(--) Selfish: Self-centered or concerned chiefly with itself and its needs.	(--) Tolerant and easy-going: Inclined to be relaxed and tolerant.

APPENDIX E

GRAPHS DEPICTING THE PERSONALITY PROFILES FOR EACH DOLPHIN


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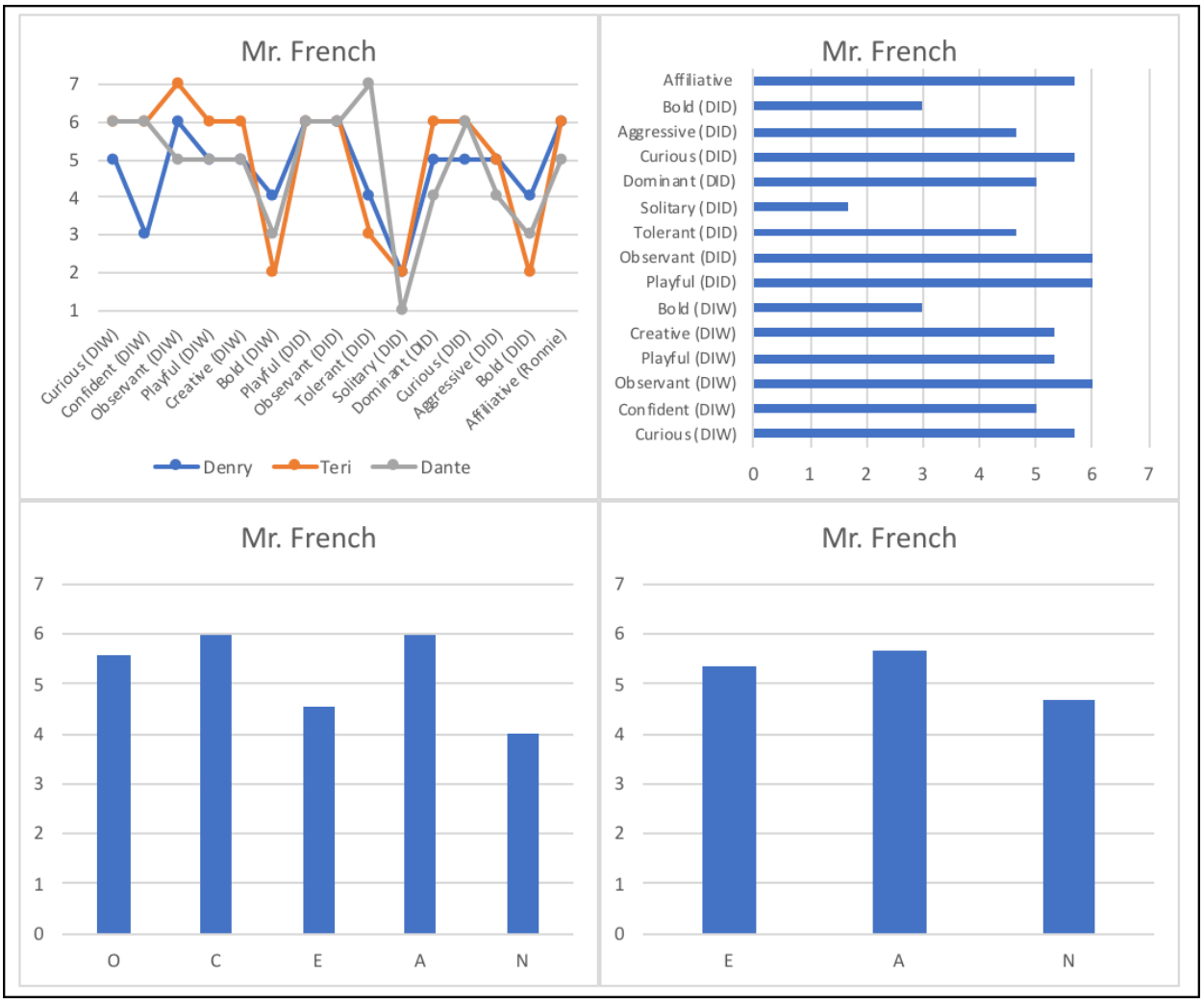
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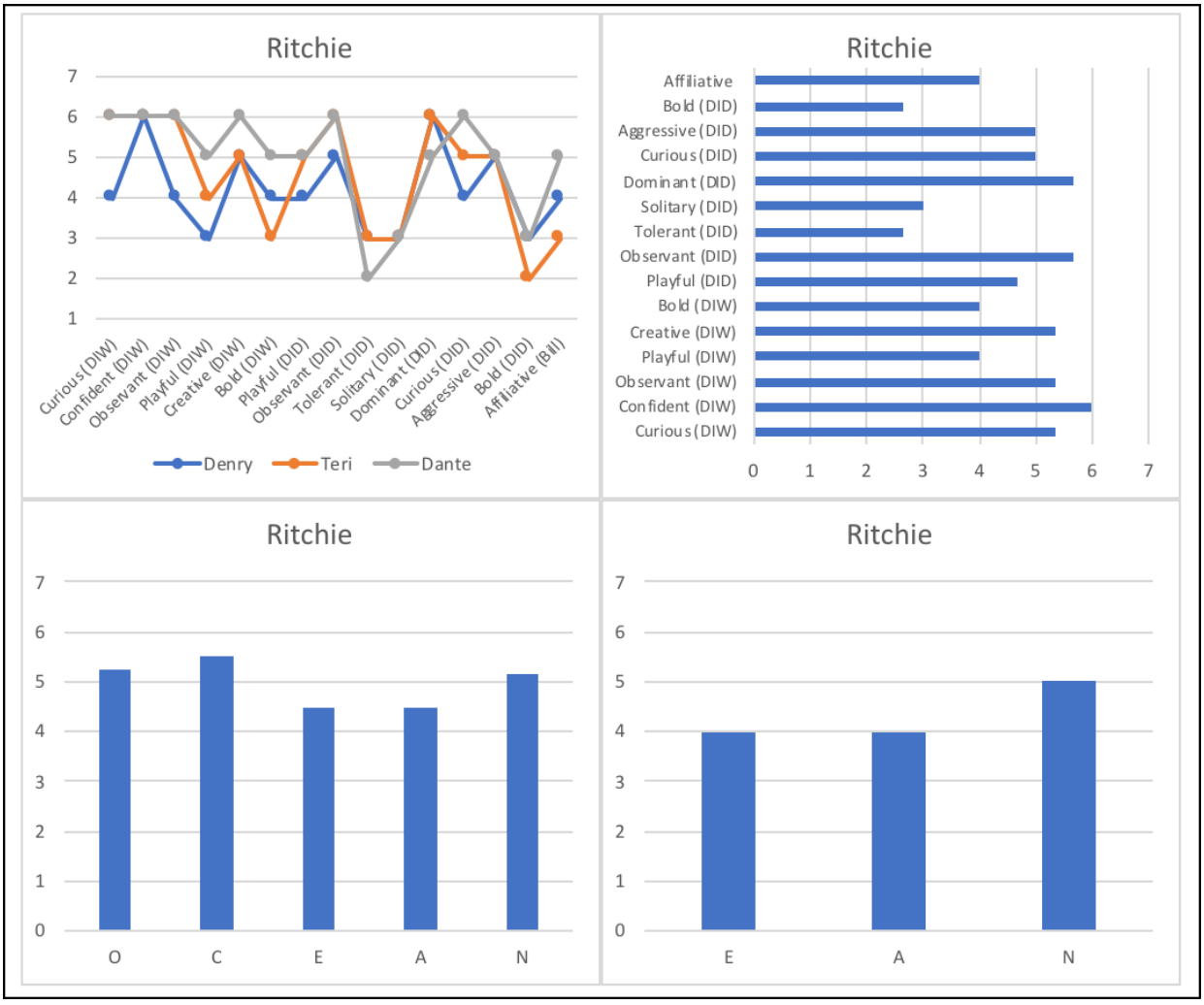
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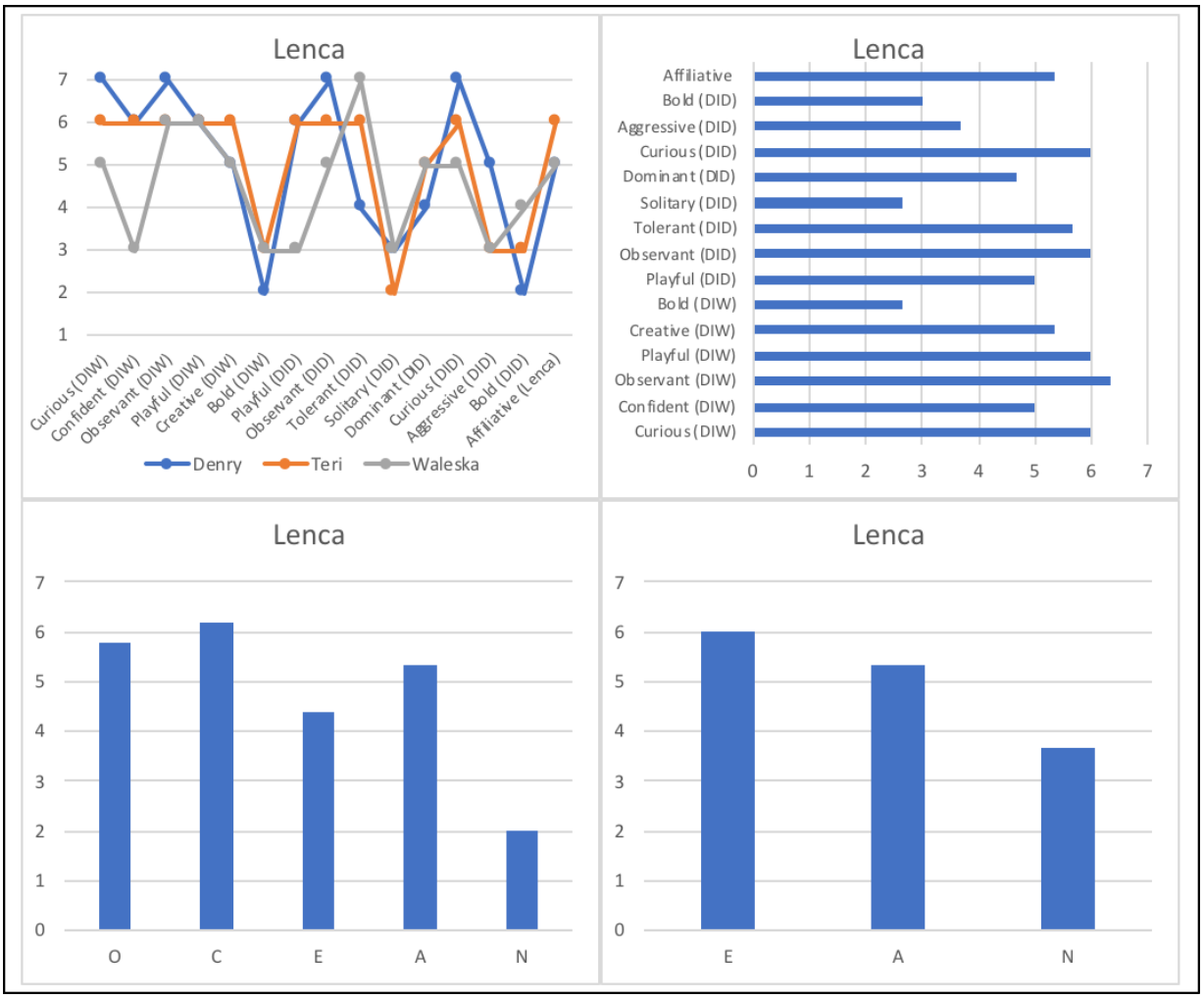
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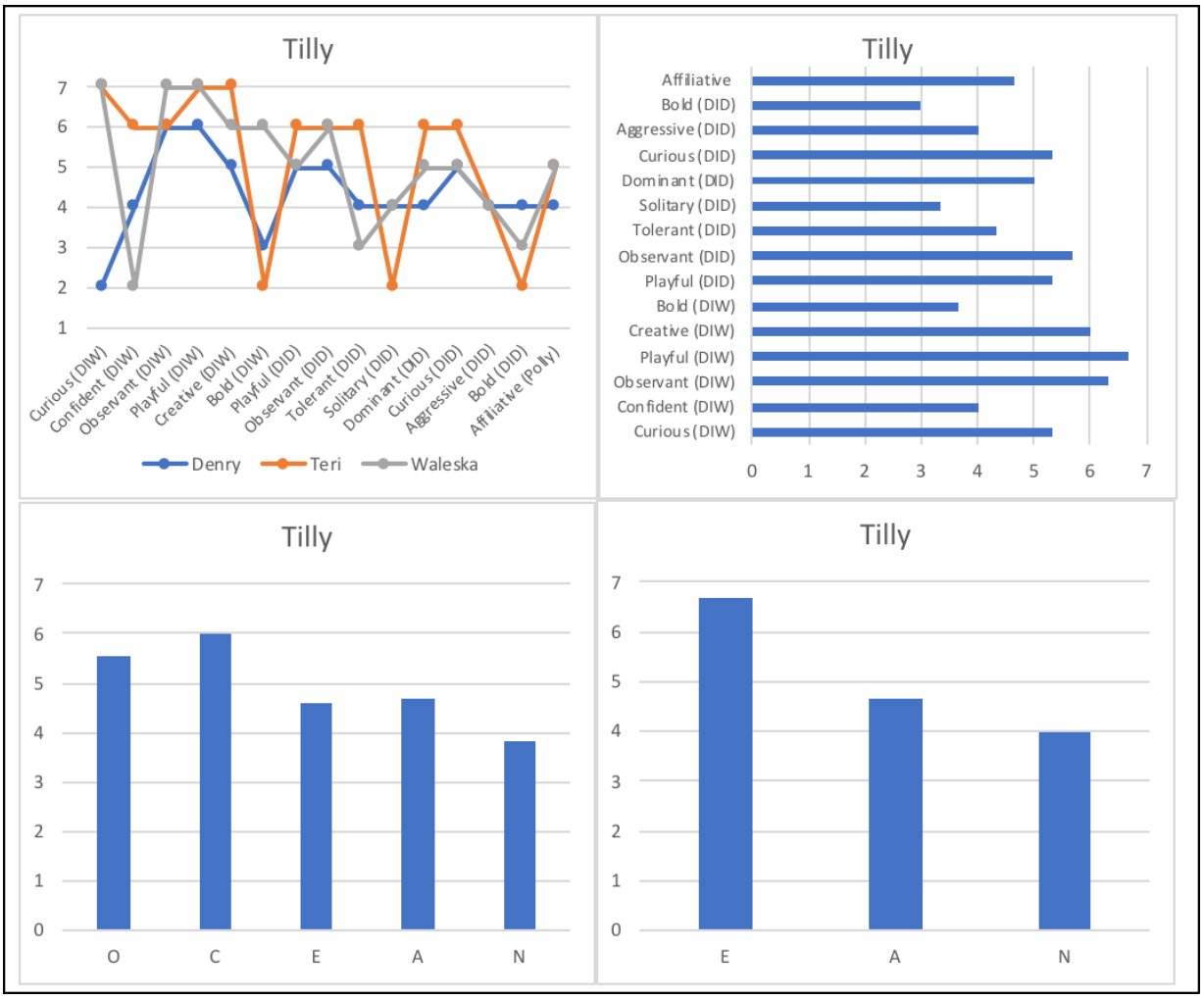
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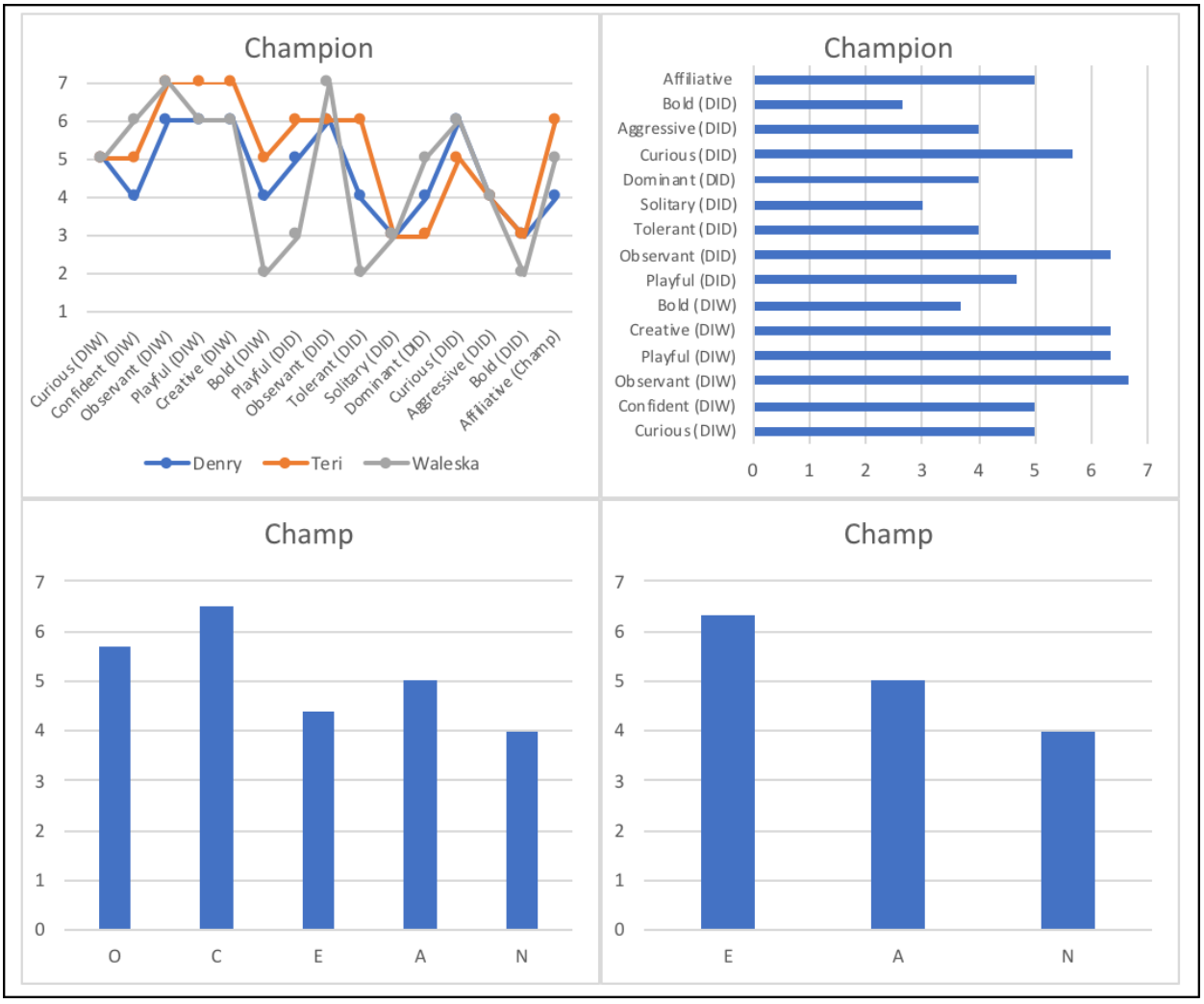
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VITA

Kimberly Bagley was born in Vicksburg, MS to the parents of Ray and Patricia Bagley. She is an only child and the mother to a 9-year-old son. She graduated from Warren Central High School and enrolled in Hinds Community College. She continued on to The University of Southern Mississippi to pursue an education in marine mammals. Kimberly began working with Dr. Kuczaj in the Marine Mammal Behavior and Cognition Lab and Dr. Jawor in the Behavioral Endocrinology Lab. She traveled with Dr. Kuczaj to Roatan twice as part of a Study Abroad Program. She completed her Bachelor of Science degree in May of 2016 in Psychology with a minor in Biology before accepting a position as a graduate student at the University of Tennessee at Chattanooga in the Research Psychology Program. Kimberly graduated with a Master of Science degree in Research Psychology in May 2018.