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Defining Creativity and Confirming Understanding of the Concept in Dolphins: Research and Training Perspectives

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Abstract

Dolphin cognitive abilities have been examined by establishing a concept-oriented cue, the *innovate* discriminative stimulus (S^D), wherein an individual is required to perform something new or different upon each stimulus given. Although a number of facilities have trained this behavior with a wide range of species, neither the training nor the level of creativity in response to this cue has been researched systematically. Moreover, differing criteria exist for whether novel or different behaviors should be defined as *innovative* as evidenced by the research to date. Ultimately, our goal is to establish a research and training protocol for using the *innovate* S^D to assess the creative abilities in nonhuman species. We compared *innovate* training methodologies used with dolphins specifically, although a number of other species have been trained on this behavior based on anecdotal reports. Our literature review, including discussions with trainers, indicated that a number of potential pitfalls occur when training this cognitive task (e.g., avoid shaping a chained behavioral response). This methodological review provides both a clear definition of the criteria accepted for innovative behavior and a suggested approach for training and testing this concept in dolphins. Finally, the more unambiguously that we understand innovative behavior in a controlled setting, such as under stimulus control, the more we will be able to gain from studies of spontaneous behavior and other examples of behavioral innovation observed in the wild.

Key Words: innovative, creative, cognition, training approach, bottlenose dolphins, *Tursiops truncatus*

Introduction

Many species have fairly basic behavioral repertoires that include foraging, mating, defending territory or mates, resting, and socializing. Yet, despite these universal components, species and individuals within species create or innovate unique and novel variations of these components. For example, foraging in delphinids is represented in multiple species with a variety of novel strategies by which the problem of finding and catching prey has been solved; methods include those that can be performed independently or cooperatively. Novel behaviors observed in natural habitats included sponging (Smolker et al., 1997) and conch shell use (Allen et al., 2011) by foraging bottlenose dolphins (*Tursiops* sp.), strand-foraging (Guinet & Bouvier, 1995) and ice-flow hunting (Visser et al., 2008) by killer whales (*Orcinus orca*), as well as courtship behaviors and mating rituals by boto (*Inia geoffrensis*; Martin et al., 2008) and humpback dolphins (*Sousa chinensis*; Parra, 2007). When observing dolphins in managed care, there are numerous anecdotes of individuals, pairs, and small groups creating their own play behaviors (e.g., cooperative use of bubbles; Marten et al., 1996; McCowan et al., 2000; Kuczaj & Highfill, 2005) and creating their own environmental enrichment opportunities (e.g., Kuczaj et al., 2002; Delfour, 2010), as well as spontaneously imitating humans (e.g., Kuczaj et al., 2012).

Based on anecdotal observations alone, it is difficult to confirm the existence of creativity in dolphins. Investigating natural behavior related to creativity requires prior knowledge of an individual's behavioral repertoire. In the human literature, definitions of creativity involve two main characteristics: (1) novelty and (2) appropriateness to the task (Kaufman & Baer, 2012). Mayer (1999) narrows the definition of *human creativity* to two key characteristics: (1) originality and (2) usefulness. These two characteristics can impact an individual's ability to solve problems, perform actions, and adapt to unfamiliar environments. Moreover, these consequences are also applicable to nonhuman animals. Investigation into how nonhuman animals develop and use creative thinking for memory and actions has been sparse. In a controlled setting, dolphins have been taught (i.e., trained) to respond with innovative behavior using a discriminative stimulus (S^D) or cue (Pryor, 1975; Mercado et al., 1998; Kuczaj & Eskelinen, 2014; Lawrence et al., 2016). This training method has been used to demonstrate dolphin intellectual abilities, which can be examined through training new behaviors after capturing behaviors produced during this *innovate* stimulus, providing enrichment to animals or reducing boredom, and testing their cognitive abilities (e.g., memory for actions). Although dolphins are the focus of this paper, many other species have been trained in various ways on this cue for many of the same reasons listed above for dolphins (e.g., vocal novelty in walrus [*Odobenus rosmarus*; Schusterman & Reichmuth, 2007]; object labels in grey parrots [*Psittacus erithacus*; Pepperberg, 2015]). Most recently, in a survey of facilities housing dolphins and sea lions, 15 facilities out of the 54 that responded reported using the *innovate* behavior in their training sessions (Yeater et al., 2014).

Innovate (also called *create*, but the term *innovate* will be used for the remainder of the paper for consistency) has been defined and empirically investigated in a variety of approaches with marine mammals. At least three variations of *innovate* training are represented in the literature with respect to asking dolphins to be innovative on request: (1) examining novelty in behavior(s) that had not been previously observed or reinforced (Pryor, 1975), (2) reinforcing behaviors previously learned while not repeating an immediately preceding behavior (Mercado et al., 1998), and (3) reinforcing varying strings of behaviors (i.e., chained behaviors) within each test trial (Kuczaj & Eskelinen, 2014; Lawrence et al., 2016). These varying methods and subsequent publications produced a variety of terms that have been used interchangeably, although their true definitions are not the same: innovate, create, new, different, novel, any, and vary. Each term comes with an individualized interpretation that confounds existing and future training approaches. For example, is the first behavioral response counted as new or is a chain involving a sequence of previously produced behaviors with the addition of a new behavior at the end counted? Each scenario presents unique issues discussed in greater depth below.

The purpose of this paper is to catalog and explain training methodologies used to shape the concept of *innovate* in dolphins, although these methods are applicable across all species. First, we compare and contrast the various training methods that have been published on *innovate*. Next, we aim to establish a research and training protocol for examining creativity in dolphins. To do so, we will summarize the challenges and processes involved in the training methodology. Then, we will present a research protocol used to assess creativity in dolphins.

Methods

Two methods were used to obtain data for this paper: (1) a survey of facilities and trainers was conducted to understand the existing methods for training *innovate* to dolphins; and (2) a literature review of methods applied and studies conducted into creativity was completed to inform the discussion related to different training approaches as well as to allow for a more comprehensive understanding of the cognitive processes that can be identified with respect to creativity from a research perspective.

Previous Methods Reported for Innovate *in Dolphins*

Since Pryor et al. (1969) published "The Creative Porpoise," only seven other papers have reported results related to dolphin creativity under stimulus control. A review of each of those publications indicated that only three original studies collected data from a total of seven dolphins—two rough-tooth dolphins (*Steno bredanensis*; Pryor et al., 1969; Pryor, 1975; Pryor & Chase, 2014) and five bottlenose dolphins (*T. truncatus*; Braslau-Schneck, 1994; Mercado et al., 1998; Herman, 2006; Kuczaj & Eskelinen, 2014; Lawrence et al., 2016)—although more animals have been trained and not formally tested on their understanding of the *innovate* concept.

Each study incorporated different training protocols (e.g., schedule of reinforcement or type of reinforcement) and criteria for accepted behaviors (e.g., novel, different, or variation of previous behavior), most of which were inferred from the text or through personal communication with several experienced trainers who conducted the training and testing sessions or were present during them (see Table 1 for a comparison between papers). After reviewing the published methodologies and personal communications, the largest difference between studies appeared to be the training methods used, which included the reinforcement schedule, use of the Least Reinforcing Scenario (LRS) to respond to incorrect behaviors (Scarpuzzi et al.,

Table 1. Comparison of literature reporting *innovate* concept in dolphins

	Pryor et al., 1969	Pryor, 1975	Braslau-Schneck, 1994 (Summarized in Pryor & Chase, 2014)	Mercado et al., 1998	Herman, 2006	Kuczaj & Eskelinen, 2014	Lawrence et al., 2016
Species	Rough-tooth dolphins (*Steno bredanensis*)	Rough-tooth dolphins (*Steno bredanensis*)	Atlantic bottlenose dolphins (*Tursiops truncatus*)	Atlantic bottlenose dolphins (*Tursiops truncatus*)	Atlantic bottlenose dolphins (*Tursiops truncatus*)	Atlantic bottlenose dolphins (*Tursiops truncatus*)	Atlantic bottlenose dolphins (*Tursiops truncatus*)
Sample size	2	2 Same sample population as Pryor et al. (1969)	2	2	2 Same sample population as Mercado et al. (1998)	3	3 Same sample population as Kuczaj & Eskelinen (2014)
Sex	Male & female	Male & female	Male & female	Male & female	Male & female	Male	Male
Age class	Adult: 2	Adult: 2	Adult: 2	Adult: 2	Adult: 2	Adult: 2 Subadult: 1	Adult: 2 Subadult: 1
Term used in the paper	"Create"	"Create"	"Create"	"Any repeat"*	"Create"	"Vary"	"Vary"
Training steps	Produce a novel behavior not part of the normal swimming action of the animal: Fixed Ratio 1 (FR1) reinforcement (small fish)	Produce a novel behavior	Not indicated other than do something different than previous trial	Not indicated	Required to create their own behavior; sequential create asks must be different from previous	Simple (e.g., wave or whistle) to complex (wave + whistle)	Analysis of the influence of reinforcement on producing behaviors in create: FR1, with reinforcement variety (e.g., primary and secondary)
Frequency of training sessions	Minimum: 1/day	Not indicated	Daily ¼ of diet was allocated to cognitive tasks; trained separately	Animals trained in Braslau-Schneck (1994) but tested in this study	Same as described in Braslau-Schneck (1994) and Pryor et al. (1969)	Minimum: 1/wk per dolphin	Minimum: 1/wk per dolphin
Criteria for correct performance	Behaviors were reinforced if not produced before	Only things which had not been previously reinforced were reinforceable	Could perform a behavior already performed in a session no less than 4 trials before	Animals trained in Braslau-Schneck (1994) but tested in this study	Same as described in Braslau-Schneck (1994)	(1) Novel behavior, (2) combined behaviors in unique way (specific sequence could not be used in same session), or (3) did not reinforce for producing same behaviors each session	Terminated trial after repeated behavior (LRS); same as in Kuczaj & Eskelinen (2014)

Timeframe	In a session	In a session	In a session	In a session	In a session	In a session	In a session
Mastery criteria	Reinforced for 1 type of response through session	Not indicated	A behavior that had not been performed in session; did not have to be truly novel	N/A	As described in Braslau-Schneck (1994)	4 successive training sessions require new behaviors without repeat; subjects required between 69 to 74 training sessions	4 successive training sessions require new behaviors without repeat; subjects required between 69 to 74 training sessions
Testing sessions	Not indicated	Not indicated	24 discrete trials; no reinforcement given following a correct response to *innovate* S^D; 10 sessions with variable reinforcement schedules	N/A	As described in Braslau-Schneck (1994)	Test sessions after mastery; individual assessment	Test sessions after mastery; individual assessment
Coded categories	Novel behavior only	Novel behavior only	Able to do combinations/ sequences	Creativity index; number of different behaviors	Not indicated	Number of behaviors offered per create ask; complex behavior divided into components, energy levels (low, medium, high), and novelty	Quantify the relationship between behaviors offered in create and the reinforcement history associated with those behaviors

*Three cues that each meant something different, but this is the one concentrated on in this paper.

1991), the criteria used for determining acceptable response behavior, and the desired behavior (i.e., novel, variation, or different). Incorrect behaviors for Pryor et al. (1969, 1975) were known behaviors from the subjects' repertoire or behaviors that were not truly novel. Incorrect behaviors for Mercado et al. (1998) and Herman (2006) included immediately repeated behaviors one after another; however, a behavior was allowed to be repeated later in the same session. Kuczaj & Eskelinen (2014) and Lawrence et al. (2016) reported incorrect behavior as *any* repeated behavior within the same trial or session. In addition to these differences in methodologies, it was unclear how the trainers dealt with issues regarding the animal's understanding of the concept. For example, what did the trainers do when an animal "got stuck"? Did trainers provide cues to the animals? Did trainers attempt to shape the behavior? Did trainers or dolphin responses end the session? Did trainers redirect the animal? These topics both form the basis for results gleaned from the procedure comparison and inform the resulting proposed method for training the *innovate* S^D when research into dolphin cognitive abilities is the primary goal.

Results

Proposed Training Protocol

Based on previous experience training the *innovate* cue, as well as a review of the sparse literature on the topic, we compiled suggested methods for *innovate* training and included the reasons why these approaches are recommended. Potential pitfalls for each method are also listed. This section is divided into several subsections: information prior to initial training and testing, the trainer perspective in training (i.e., desired responses and characteristics of a training session), the dolphin perspective in a training session, and research of the *innovate* S^D response (i.e., perspective and considerations during testing).

Prior to Initial Training and Testing

Establishing a strong rapport between the research and training staffs is crucial to advancement in training. Animal training is based on scientific principles, yet it is rarely empirically investigated (Young, 2002). Bridging the gap between the research and training departments can assist in garnering additional information about the cognitive abilities of other species. Although it is rare to have individuals who are familiar with the fundamentals of both research and training, routine meetings with the two groups will augment communication and troubleshooting. Trainers with advanced skills are typically preferable when training the concept of *innovate,* mainly because of the differences associated with training a cognitive concept (e.g., vary or match to sample) vs a standard behavior (e.g., wave or flip). Since the desired outcome of *innovate* is to have the subject continuously perform different and/or novel behaviors, the reinforcement strategies (e.g., bridges vs immediate primary or continuous vs intermittent reinforcement) used will be vastly different when training this concept as compared to that of behavior (e.g., husbandry or presentation) training.

Training: Trainer Perspective

Most marine mammal facilities rely on positive reinforcement to execute training paradigms to increase the frequency of a desired behavior (e.g., Perkins, 1968; Heidenreich, 2007). Although little information is available in the peer-reviewed literature on exact reinforcement strategies used when training the *innovate* concept, anecdotal information suggests that different facilities have had success training *innovate* through Variable Reinforcement (VR) (i.e., magnitude of the reinforcer), Variable Ratio with Reinforcement Variety (VRRV) (Force & Butcher, 1985), and Fixed Ratio (FR) (Ferster & Skinner, 1957). However, variable schedules of reinforcement are suggested to elicit the highest and most consistent response rate (Kazdin, 2001). The LRS (Scarpuzzi et al., 1991) has also been successfully and strategically applied when a subject incorrectly performs a behavior with *innovate*, depending on the scientific goal of the project (e.g., not varying behaviors or lack of novelty). Unlike using punishment, the LRS is a learning tool that assists in eliminating unwanted behavioral responses while keeping the training sessions motivating (e.g., Wiard, 1972; Scarpuzzi et al., 1991; Ramirez, 1999). Most established training departments have reinforcement schedules for daily training needs (e.g., husbandry, show, and interaction behaviors), thus the animals are familiar with this practice, and deviating from it simultaneously while training *innovate* could result in frustration or lack of success. Reinforcement affiliated with creativity-contingent behaviors is suggested to possess a greater impact than performance-contingent rewards (Byron & Khazanchi, 2012). To assist in an animal's success in learning the *innovate* behavior, research and training staffs should place extra attention on the purposeful planning of reinforcement as non-strategic schedules of reinforcement can hinder the success of *innovate* training (Turner et al., 2017).

Based on reported trainer experiences, the more variable the trainers are from the beginning of *innovate* training on the behaviors they accept as correct, the greater will be the degree of variability in behaviors offered. Variable strategies may include asking the animal from different areas in the pool/lagoon, asking the animal to sink below the surface prior to giving the *innovate* S^D, or accepting familiar behaviors performed in novel contexts such as vocalizing softly and then loudly. Practicing variability during training provides the animal with different contexts in which the behavior is being asked, and reinforcement may potentially elicit a greater variable response (Force & Butcher, 1985). This practice could also include asking for the *innovate* behavior off session without reinforcement as this may elicit more varied responses (e.g., Anonitis, 1951; Gharib et al., 2004). However, be mindful when using this technique as it may cause frustration due to ratio strain (i.e., low reinforcement frequency) (Skinner, 1969).

Due to varying training scenarios and levels of motivation, not all animals are successful at the *innovate* task. Trainers should be extra mindful of subjects remaining motivated by the task, and reinforcement should be provided at meaningful points to elicit the desired response (e.g., Pryor, 1985). Understanding the motivators that drive each subject (e.g., reinforcement and location; Savastano et al., 2003) as well as determining an animal's state, mainly focusing on the presence of frustration while learning the task, are crucial to advancement in *innovate* training. Amsel (1958) defined *frustration* as a reactionary response of a non-reward following a number of rewards; thus, repeated exposure to frustration can induce aggression (Duncan et al., 1971). Alternative forms of training may be used, including "errorless" learning where the number of incorrect responses is minimized (Terrace, 1963). Ultimately, concentrating on making the task reinforcing is critical to all successful training, including this cognitive task.

Desired Responses—Desired responses are based on the research objective and pivotal in assisting subjects in understanding the desired cognitive concept. The conditioned or secondary reinforcer of the *bridge* cues the subject to impending reinforcement (e.g., Pryor, 1985). Effective bridging maximizes reinforcement, linking the target behavior to reinforcement delivery (e.g., Turner et al., 2017). Non-deliberate bridging can cause confusion, while accurate placement of the bridge combined with meaningful reinforcement assists with clarity in training, ultimately assisting in clarity for the subject in learning this concept. Pryor et al. (1969) used a bridge as an *event marker*, applying the whistle (bridge) during the desired behavior, rather than after, to deliberately select the behavior for reinforcement. Initially, trainers should bridge subtle behavioral differences, variations in a theme, as well as varying combinations of behaviors, while being mindful of behavior sequences, as this is chaining not *innovate*. Routines in which the animal appears to produce the same order of behaviors can become stereotyped responses. A stereotyped response may develop due to mistimed bridging; however, it is also important for trainers not to limit the subject to a certain correct response but to be open to a variety of different responses to encourage the subject to vary their responses in a multitude of different ways (e.g., context, variations of a behavior, or location of emitted behavior).

Characteristics of Innovate *Training Sessions*—Reinforcement delivery occurs when the subject performs the "correct" behavior, a variant behavior than previously performed. Due to the numerous correct options for response, operationally defined by researchers, the animal has more opportunities for success than failure. Still, since most subjects have strong reinforcement histories with working on successive steps to mastering a single behavior, the repetitive nature of this type of training may result in the individual repeating the previously performed behavior. Working through this step takes time and patience. As animal training professionals, it is vital to look for slight variations in a behavior than the preceding behavior to maximize reinforcement opportunities when conducting *innovate* training. For example, the animal may offer a simple wave on the first S^D request; then, on the second S^D request, the animal may offer that simple wave with a slight lean to the left. These instances should be rewarded, especially during the initial stages of *innovate* training. Subtle changes in behavioral responses to the *innovate* S^D are typically the first responses for subjects varying their behavior, thus proper reinforcement will elicit desired responses. It is important for the training staff to be mindful that the offered behavior, regardless of the stage of training, might be subtly or distinctively different from the preceding behavior. Recognition of these modifications through bridging and variable reinforcement and reinforcers should strengthen the animal's understanding of this concept.

Since subjects can backtrack quickly when not exposed to a cognitive task regularly, sessions should occur a minimum of once per day, five to seven days a week. However, conducting multiple sessions at varying times of the day and incorporating *innovate* training into other training sessions (e.g., for show or husbandry behaviors) may generate a greater level of interest and variability in the task. Placing primary reinforcement around the habitat (hiding), as well as varying session length, number of trainers present, location of *innovate* S^D, or other specifics, facilitates novelty and increases the likelihood for reinforcement (Pryor et al., 1969; also see Pryor & Chase, 2014). These tools provide the individual(s) with various learning conditions in which to perform the task, with the goal of promoting varied response.

Trainers can opt to use a variety of techniques to elicit a desired response. Using tools like Differential Reinforcement, such as Differential Reinforcement of Incompatible (DRI) behavior (see Kazdin, 1994; Malott & Shane, 2013), is crucial to assisting the animal(s) in being more variable in their responses. For example, if the individual is not progressing and is offering the response of jumping for *innovate* requests repeatedly, a DRI of having the animal hold its chin on the dock can assist the subject in varying its behavior. The subject is unable to hold its chin on the dock and jump simultaneously, thus a varied response will usually be elicited rather than reverting back to the desired behavior of jumping. Ultimately, the trainer should be looking for all types of behaviors at varying energy levels, above and below the water's surface, during all stages of *innovate* training to maximize reinforcement opportunities, prevent the subject from fixating on a given behavior, and promote diversified responses.

Termination of a training or testing session depends on variables such as the motivation of the individual animal, a session's goal, and previous training progress. When beginning training the cognitive concept of *innovate*, end of session may be after two or three S^D presentations that are comprised of incorrect and correct performance responses or continue for multiple requests. An important note is that individuals will fail during each training and/or testing session; perfection is not the goal of this cognitive task but, rather, progression and higher ratios of correct responses. Keeping the session shorter in duration, especially at initial stages of training, can facilitate the learning process and increase an animal's attention threshold (e.g., Savastano et al., 2003; Turner et al., 2017). During training (but not testing; see below), hints or pairing two cues (*innovate* plus a known behavior, particularly one that is incompatible with a repeated behavior) can be used to help the animal get back on track. Capturing small approximations of a varied behavior and immediately administering reinforcement will also continue to promote variability and allows for more reinforcement opportunities while not taxing the learning threshold (e.g., Sullivan, 2002; Savastano et al., 2003; Davis & Harris, 2006). Trainers must be mindful to reinforce all forms of variety. Prompting or priming, as when a trainer moves their body in a purposeful manner (e.g., leaning) without giving the S^D, can also provoke varied behavior. Frustration expressed by an animal is not ideal and can be mitigated with these tools.

Dolphin Perspective

The subjects chosen for *innovate* training need to be considered carefully. Recognizing individual differences means identifying the animal's susceptibility to frustration, high motivation for participating in different tasks, and an interest in solving problems or challenges. In human creativity research, it was recently discovered that people's beliefs in their own creativity was strongly predicted by the *Big Five* personality traits of openness and extroversion (Karwowski & Lebuda, 2016). Dolphin personality has been suggested to be an important component to consider when training individuals (Highfill & Kuczaj, 2007).

Dolphins may possibly produce behaviors within certain preferences. Potential behavioral categories that different dolphins use preferentially when asked to innovate may include husbandry (open mouth); simple show behaviors (fast swim); complex show behaviors (compound behaviors such as spitting while jumping simultaneously); and natural (vocalizations or bubbles), aerial, and basic (e.g., Kuczaj & Eskelinen, 2014; Yeater et al., 2014) behaviors. The expression of this diverse list of behaviors may be influenced by the trainers, especially behaviors with strong reinforcement histories (e.g., Lawrence et al., 2016), as well as the serial position effect (primacy and recency) of the behavior (e.g., Murdock, 1962). Behaviors expressed might also be influenced by individual preferences. Kuczaj & Eskelinen (2014) found that two-thirds of subjects offered low-energy behaviors more frequently compared to high-energy behaviors. Another alternative to facilitate diversity in the dolphin's repertoire is to provide a variety of objects that can be manipulated in different ways. Some dolphins may be more creative with something rather than themselves. Carrying a mat on one's head or jumping while tossing a ball may help a subject perform different behaviors beyond motor actions or vocalizations.

Research of Innovate *S^D Response – During Testing*

Once *innovate* training is stable for an individual, testing the cognitive task can commence. As did the training segment for the *innovate* S^D, the testing phase to examine how creative or innovative an individual (e.g., a dolphin) is will have both trainer and researcher perspectives.

Trainer Perspective—During testing, the trainer should reinforce consistently while using the same criteria as when training. The number of trials in a testing session is contingent upon the animal and the level of interest in responding to the *innovate* S^D. *Innovate* training varies between institutions, but we recommend that a dolphin should not be given more than three S^Ds with no repeated (i.e., incorrect) responses. Cognitive tasks are designed to be mentally stimulating to the animals (see Clark, 2013), and maintaining an animal's engagement in the task relies on minimizing frustration and lack of interest (Meehan & Mench, 2007). Repetitive incorrect responses may lead to an adverse reaction to the *innovate* task and thwart testing progress. Should an animal repeatedly respond incorrectly, fail to station, or lack interest during the session, an LRS can be applied, and testing should resume later. The goal during testing is to maximize the number of S^Ds given and the number of creative responses provided by the dolphin without priming or prompting.

Researcher Perspective—Prior to testing sessions, the subject needs to show mastery of the *innovate* cognitive task. Setting a criterion such as a non-repeat contingency for a desired number of asks/behaviors over a designated number of trials (e.g., three repetitive asks with no repeating behaviors; Kuczaj & Eskelinen, 2014) gives insight if advancing to the testing phase is appropriate. Subjects should meet the desired mastery protocol (set forth by the research staff) several times, validating the animal's true ability. If the goal of the research testing is to determine the maximum threshold of "innovative" behaviors in a session, then the key element is to establish a session termination criterion such that once the animal begins to repeat a behavior (i.e., three repeated responses in a row), the session is ended. It is likely that even if an animal produces a repeated behavior (particularly in test sessions that are contingent on truly novel behaviors or behaviors that must be different from all other behaviors performed in that session), the animal should be offered additional S^D opportunities until the termination criterion is reached or the testing session (based on desired trials) has finished. From the researcher perspective, the subtle variations of behaviors (turn right, followed by turn left) are acceptable as these behaviors might be novel for the session but not necessarily more original or elaborate. By this point, researchers and trainers have set the expected criteria for behavior acceptance as creative based on the research goals, whether those goals are to emit a truly novel behavior, a different behavior from any other behaviors presented in the same session, or a different behavior since the last behavior. These goals should be determined prior to *innovate* training. Behavioral ethograms and accurate documentation of emitted behaviors during training sessions are critical components to assessing progress overall. However, for animals that excel at the task, *post hoc* analysis via video is beneficial for assessing fine-scale differences in behaviors and elaborate strings of behaviors.

Considerations During Testing—One limitation for both training and testing the *innovate* cue is visibility from the surface. It is impossible for a trainer (or researcher) to see every underwater behavior from only a surface vantage. Thus, we recommend using underwater video recording during test sessions in addition to an above water video recording. Pryor et al. (1969) had observers at underwater viewing windows to record behaviors in addition to videoing the sessions (see also Pryor & Chase, 2014). Having the trainer call out the behavior that the animal performed and was bridged for is helpful in documenting whether the animal was correct, as well as in confirming what behavior to code. Still, it may also be worthwhile to have a blind coder present during testing to record animal behaviors in response to the S^Ds that were bridged. For fine-scale analysis, as well as reliability, analysis via video coding following the testing is recommended.

Another consideration is ending a testing session too early. Trainers need to be aware that an animal may need to "fail" a few times before a session is determined to be complete. Sometimes, the animal(s) may have a few repeated behaviors and then will offer a new behavior following a LRS or some other activity. Researchers and trainers should coordinate prior to the beginning of a test session to determine the number of "failures" an animal can experience before the session is terminated. This number may be different for each animal or may depend on previous training history. There may also be only so much available primary reinforcement.

Discussion

Examining creativity is a tool that can be used to test animal cognition while also providing cognitive enrichment to animals under human care (e.g., Maple, 2007; Clark, 2013). Innovate is one of the basic behaviors reported by a number of facilities worldwide and is often used in dolphin programs (e.g., shows) to illustrate their creative and/or cognitive abilities. It is an abstract concept, and training will take time and require patience. Although *innovate* has been taught and used extensively across numerous facilities, especially for dolphins, the subtle intricacies of research training and testing this cognitive task are represented sparsely in the literature. Additionally, *innovate* training approaches have not been examined in detail nor have they been consistently applied across or between facilities.

The purpose of this paper was to compile substantiated practices for training *innovate* behaviors with reference to various research goals to be assessed during testing. Although this paper was specific to bottlenose dolphins in human care, the methods proposed herein are applicable to many other species. A handful of studies (see Table 1) provided the foundation for the current methodological summary. *Innovate* has a number of definitions from producing a single behavior different from a previous response (Mercado et al., 1998) to producing a completely novel, never-before-seen behavior (Pryor et al., 1969). The goals of the researcher and trainer will determine what the accepted criterion will be for both training and testing (research) trials. For example, if the criterion is to only produce novel behaviors, only a few animals may learn this behavior, and it may require an extended amount of time to train (Pryor et al., 1969). In contrast, if the criterion is to produce something different (vary behavior), whether it is within a session or across specific trials, then more animals may succeed (e.g., Kuczaj & Eskelinen, 2014).

An individual's motivation to learn a new cognitive concept will also impact success; an unmotivated individual is unlikely to succeed, especially during training. Individual differences in the trainers and the animals will likely impact creativity responses, generalizing from recent research with humans (Karwowski & Lebuda, 2016). The training protocol, including the schedule of reinforcement and differential reinforcers (i.e., magnitude and preference), will influence final behaviors produced during testing sessions. Also, timing of the bridge during training is critical to learning the concept. Appropriate bridging should reduce the probability of stereotyped responses. With vastly different directions, definitions, and approaches affiliated with *innovate* training, the research team must have a strong understanding of the desired direction of the empirical investigation and be able to have communicated those details to the training team. Outlining a clear plan of objectives to relay to the training staff is of paramount importance as this allows the training staff to create meaningful training plans before training sessions begin.

One important point that we have learned about human creativity is that people can become more *innovative* (i.e., produce a number of different uses for a particular items) using extrinsic rewards, but creativity may drop off if the extrinsic reward is removed (Amabile, 1996). Based on the current definition of *innovate*, whether nonhuman animals can become more creative over time has not been explored, although it would be an intriguing study to determine if the same rules affect animals. Once a subject is performing *innovate* under stimulus control, the degree of creativity is then assessed. Like all constructs, a standardized coding procedure must be implemented to compare the creativity of one subject to another.

The *innovate* training and testing approaches reviewed in this paper focus on taught creativity rather than spontaneous creative actions. An extension of this examined cognitive concept of creativity in a controlled setting would be to document spontaneously creative behavior from dolphins in both captive and wild settings. Evidence of dolphins' cognitive flexibility and imitation research (Herman, 2002, 2006; Kuczaj & Walker, 2006; Kuczaj & Yeater, 2006) suggests that dolphins are naturally creative; for example, Herman (2006) asked dolphins to "do what I [the trainer] do" and then trained the reverse ("I'll [the trainer] do what you [the dolphin] do") as a spontaneous game. Although never quantitatively assessed, this game produced perhaps even more creative behaviors than when the dolphins were responding to *innovate* S^Ds under stimulus control (E. Mercado, pers. comm., 17 December 2017). Research on creative behaviors under stimulus control allows for less impact of potential confounds and for greater control of learning history and behavioral repertoire. Similarly, coordination with researchers with long-term behavioral datasets on dolphins in the wild could offer insight into novel actions that depend on context or interaction between individuals.

Creativity research with nonhuman animals demonstrates adaptability to a changing environment, problem solving, cognitive flexibility, and behavioral inventiveness. The ability to think innovatively in the wild has been manifested in foraging specializations and cultural traditions. Creativity occurs in the wild by solving problems using various strategies, whether hunting food or securing a mate. To evaluate creative dolphins in the wild, we first need to understand the learning constraints of animals using an experimental method requiring stimulus control. Then, we can correlate creative behavior in an experimental procedure with spontaneous innovative behavior observed in managed care settings. Ultimately, it may be possible to develop field studies incorporating the ideas of originality and elaboration of behaviors or techniques based on studies of spontaneous creativity (e.g., killer whale hunting of seals on ice floes [Visser et al., 2008] or dolphin sponging [Smolker et al., 1997]).

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