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There Is No Substitute for an Experimental Analysis of Marine Mammal Cognition

In our three page note published in this journal (Kastak and Schusterman 1992) regarding the comparative cognition of marine mammals, the final paragraph stated that: "Without standardizing laboratory MTS [match-to-sample] tests of transfer relations there are alternative interpretations of supposed abstract concept formation. This certainly does not mean that sea lions and dolphins are incapable of such cognitive processes . . . but [that] more rigorous analysis may help clarify the issues and lead to a better understanding of comparative cognition in marine mammals" (p. 416). However, Herman and his colleagues (Herman *et al.* 1994) have chosen to ignore our closing statement and instead have focused on an earlier phrase: "Based on the effects of exclusion . . . alternate explanations may exist that account for the . . . [dolphin or sea lion's] 'quick' or 'immediate' transfer of an 'abstract relationship' " (Kastak and Schusterman 1992, p. 416). The critical point of our paper was that, although *immediate* transfer of an identity relation had not been demonstrated, Herman *et al.* (1989) had succeeded in demonstrating eventual acquisition of an identity concept by a dolphin (*Tursiops truncatus*) in a visual MTS format. In a recent series of experiments, we have unequivocally demonstrated that California sea lions (*Zalophus californianus*) can also eventually acquire an identity concept (Kastak and Schusterman 1994). Moreover, we have shown (Schusterman and Kastak 1993) that one California sea lion is capable of forming concepts like reflexive identity (A1 = A1), symmetry (if A1 = B1, then B1 = A1), associative transitivity (if A1 = B1, and B1 = C1, then A1 = C1), and equivalence (if A1 = B1, and B1 = C1, then C1 = A1). We suspect that such conceptual abilities in many mammals (including dolphins and sea lions) and birds function in the context of different social interactions, including alarm calling, kinship, territorial rivalry, dominance relationships and group membership. Thus, it is incorrect to accuse us [as Herman *et al.* (1994) do] as stating that evidence for the ability of bottlenose dolphins to develop abstract concepts is slender. Indeed, concerning auditory identity MTS, one of us (RJS) said the opposite in a published book chapter (Schusterman 1988), which is not referenced by Herman *et al.* (1994).

In summary, what Kastak and Schusterman (1992) and others (see Dube *et al.* 1992) did say was that the process of matching with novel stimuli may be controlled by factors other than reflexive identity. One such factor is the exclusion effect, which may occur when the comparison or choice stimuli consist of a novel positive matching stimulus paired with one or more familiar negative nonmatching stimuli. Herman and his associates have called this condition the "partial" transfer test (see Herman *et al.* 1994). In such instances the animal can respond correctly on the very first trial not by matching, but by excluding the familiar choice stimuli that have already been associated with other samples (Schusterman *et al.* 1993). To rule out exclusion as a contributing factor on tests of generalized identity MTS one must pair *novel* matching stimuli with only *novel* nonmatching stimuli.

Recently, several investigators (Dube *et al.* 1992; Kastak and Schusterman 1994;

Thompson, in press) state that the best evidence for a relational matching concept based on reflexive identity would come from a study in which the animals should learn to match with a minimal number—ideally two—of training stimuli. The stimuli are presented as both matching and nonmatching alternatives over trials until a criterion is reached. These investigators further point out that transfer tests following criterional learning should be conducted with novel stimuli that differ physically from the training stimuli and that performances on the first presentation of the transfer stimuli need to be compared with those over the first several trials in which both alternatives serve as the sample, thus eliminating the exclusion effect, and insuring that the task is a conditional discrimination. Ideally, if one wants to conclude that there is unequivocal evidence for the formation of *immediate* relational identity matching concept, then there must be no evidence of a practice effect on performance in the transfer tests, *i.e.*, performance levels on the first few trials of the transfer test with novel stimuli have to be similar to those obtained at the termination of the training sessions.

In experiments attempting to obtain generalized visual MTS in a *Tursiops* (Herman *et al.* 1989), and a *Zalophus* (Pack *et al.* 1991), Herman and his colleagues used partial transfer tests (*i.e.*, they used novel-familiar pairings). These were interposed between the time these marine mammals reached criterional learning with the original set of training stimuli presented as both matching and nonmatching alternatives over trials and the time the animals were presented with novel transfer test stimuli. The latter require the animals to compare both sets of stimuli over several trials in which both novel alternatives served as the sample. It is important to note that in the dolphin study (Herman *et al.* 1989) the animal was given several identity matches during the criterional learning phase, and in order "to improve the reliability of object matching, acoustic cueing was introduced" (p. 126). In addition, the dolphin learned three forced-choice problems (no incorrect choice was present), two of which were later acoustically cued, followed by eight "exclusion" problems before being tested in a mixed design consisting of both familiar-familiar and novel-familiar problems in addition to 6 novel-novel combinations (Herman *et al.* 1989, Experiment 3). Clearly the features discussed earlier for demonstrating the formation of an immediate relational identity matching concept in an animal are not met by either of these studies. The partial transfer condition gives the animal additional practice. However, the nature of this instructional phase remains obscured because it is unclear as to what is controlling the animal's performance. Is it the familiar choice stimuli that have been associated with another sample (exclusion), or is it the reflexive nature of the novel sample-comparison relation? Despite the ambiguity, Herman *et al.* (1989) discuss their dolphin's performance in terms of "*immediacy* (our italics) of transfer observed to new visual materials . . . rival[ing] performances observed in a bottlenose dolphin using auditory materials . . ." (p. 134) and Pack *et al.* (1991) state that bottlenose dolphins are capable of "*immediate* (our italics) transfer of the identity concept . . ." (p. 38), whereas "the sea lion developed a concept of matching and was able to apply it relatively quickly (but not immediately) to novel transfer problems . . ." (p. 44). Furthermore, Herman *et al.* (1994), without considering the exclusion effect, attempt to make a virtue out of the partial transfer test by stating it "can sometimes have a pragmatic function in helping to teach the matching problem to the animal during earlier stages of training . . ." (p. 71). How can Herman and his colleagues claim that transfer was *immediate* for bottlenose dolphins and *quick* for California sea lions when an abstruse training procedure precedes the ultimate test of the identity matching concept? We find it inappropriate of them to argue that the partial transfer tests are to be regarded merely as a "teaching" device and that *immediate* refers to *eventual* successful performance on trial one of each problem. To say that the partial transfer condition should be viewed as part of the subject's instructional training strikes us as making "immediate transfer" untestable, and that is clearly unacceptable.

There are additional reasons why the attempt of Herman *et al.* (1994) to defend previous conclusions that marine mammals can demonstrate immediate or rapid or quick generalized MTS, either during, or subsequent to the partial transfer tests do not hold up. For example, Dube *et al.* (1992) point out that in Experiment 4 by Herman *et al.*

(1989) either two familiar or two novel objects were shown (but never one of each category) and that matching was nearly perfect with familiar objects but just below 80% with novel objects. Further, initial scores of the dolphin in Experiment 2 when exclusion was possible were much higher (90%) than in Experiment 4 (69% and 78%) when exclusion was controlled for. If one wants to conclude that exclusion is not a factor in a conditional discrimination like identity MTS where there are two or more comparisons presented simultaneously, then at least two comparisons must be novel stimuli. This was not the case in the first two experiments by Herman *et al.* (1989) on identity MTS nor during the first phase of the identity MTS experiments by Pack *et al.* (1991). Our (Kastak and Schusterman 1992) criticism of methodology (not the subjects' cognitive capacities) along with that of Dube *et al.* (1992) remains cogent. In fact, tests for control by exclusion in humans and nonhuman animals seem well accepted in the scientific community and are now used extensively so as to eliminate confounding factors in interpreting performance skills on arbitrary and identity MTS McIlvane and Stoddard 1985; Dube *et al.* 1992; Schusterman *et al.* 1993; Tomonaga 1993; Thompson, in press). We would argue that a strategy used by such a wide variety of taxa in various contexts is probably used by bottlenosed dolphins as well.

In light of the above discussion about exclusion, it is worth noting that in the initial training phase for visual identity matching-to-sample for Rio, one of our sea lions (Kastak and Schusterman 1994), exclusion was used as a training strategy in order to allow the subject to "errorlessly" learn the *first* of 15 identity matching problems. The sea lion's performance on this phase of the experiment was 90% (36/40 correct responses) on the very first session. Thus, without *any* prior identity MTS training, this animal completed a set of trials analogous to Herman *et al.*'s (1989) and Pack *et al.*'s (1991) partial transfer tests at an extremely high level of accuracy. On probe trials that controlled for possible exclusion effects, however, her performance remained at chance levels for five days of training. Her performance on these probe trials during the first phase of the identity MTS improved only after receiving upwards of 160 exclusion (partial transfer) trials. This is strongly indicative of a learning effect and illustrates the logical flaw of basing conclusions regarding cognitive capabilities on tests that are subject to alternate explanations.

Our training of the sea lion in this virtually errorless manner was quite similar to the way dolphins have been trained to associate novel signs (in both the acoustic and visual modes) with "unnamed" objects (Herman *et al.* 1984). However, without further analysis, Herman *et al.* (1984) took this errorless training technique to be the process by which the signs acquired meaning for these marine mammals and came to the following conclusion: "It was sometimes sufficient to pair a new signal with an unnamed object for the dolphin to associate the two immediately. Successful association was indicated by the dolphin continuing to respond appropriately to the previously unnamed object in the presence of the new signal and the other objects . . ." (p. 157). Herman *et al.* (1984) go on to summarize their results on meaning and referentiality as follows: "The concept that signs stand for referents seems to come easily to the dolphins" (p. 207). Indeed, without questioning, or doing any further experimental analysis we would have arrived at the same conclusion about our sea lions. However, by simply using a "rule of thumb" dolphins, sea lions, children, chimpanzees and pigeons may be doing the same thing in similar situations. They respond correctly the first time, not by relating a sign with an object (paired associate learning), but by excluding the familiar objects because they have previously been associated with other signals. It is only later in the learning process in contexts where the basis for exclusion is no longer available that a novel conditional performance occurs. Without further experimental analysis this is indeed the most parsimonious explanation of how dolphins learn arbitrary sign-referent relations (Schusterman and Gisiner, in press).

In conclusion, we agree with Herman *et al.* (1994) that "The initial use of novel-familiar pairings should not detract from the findings of later tests with novel-novel pairings" (p. 79). What remains obvious, despite arguments to the contrary, is that results from such novel-familiar pairings cannot be used as evidence of an animal's ability to immediately generalize rules or apply abstract concepts. Further, as we have empirically determined (Schusterman *et al.* 1993, Kastak and Schusterman 1994), results on subsequent novel-novel testing absolutely cannot describe the strategies employed by the subjects on previous "partial transfer" tests—such partial transfer tests should be regarded as a phase of training. We reiterate that Herman and colleagues are unjustified in stating otherwise, and believe that a more thorough analysis of the arguments will put this issue to rest.

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RONALD J. SCHUSTERMAN, Institute of Marine Sciences, University of California, Santa Cruz, CA 95064 and Department of Psychology, California State University, Hayward, CA 94542; DAVID A. KASTAK, Department of Biology, University of California, Santa Cruz, CA 95064.