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Canine human-scent-matching: The limitations of systematic pseudo matching-to-sample procedures

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ABSTRACT

Here transfer performance is contrasted with baseline training performance to determine whether a relational solution strategy is learned from the systematic pseudo matching-to-sample procedures commonly used to train human-scent-matching dogs. Evidence indicates that due to the lack of constraints to control against simple discrimination solutions, dogs trained with systematic pseudo matching-to-sample arrangements do not learn to use the scent sample as a signaling cue and do not learn about the matching relationship between the scent sample and matching comparison. Moreover, during pseudo matching-to-sample training, dogs may learn to ignore both the scent sample and the discriminative dimension of human scent, such as genetic information. Thus, during subsequent random control matching-to-sample (MTS) conditional discrimination training, learning about the matching relationship between the individual-unique information on the scent sample and matching comparison can be retarded. Failure to identify the solution strategy that human-scent-matching dogs must learn in order to perform accurately and reliably during operations and to distinguish between simple discrimination, random control MTS conditional discrimination, and systematic pseudo matching-to-sample has been a major drawback to the advancement of scent-matching dogs and is a contributing factor to the continued controversy surrounding their use and reliability.

1. Introduction

In both mantrailing and lineup detection, a trial begins with the presentation of a scent sample. The dog's task is to sample the odor on the scent sample, compare the memory of that odor to two or more alternatives, and then choose the comparison that matches the individual-unique human scent information on the previously presented scent sample. In the random control matching-to-sample (MTS) conditional discrimination procedure used to study complex learning in animals, the subject's task is to compare two or more comparison stimuli with the memory of a previously presented sample stimulus and then choose the comparison that matches the sample. Although the tasks are the same, canine human-scent-matching training and testing can vary significantly from the MTS procedure used for scientific investigation. The former developed by members of the canine community and the later developed by the scientific community. Thus, there can be significant differences between the solution strategies learned and significant differences between canine accuracy rates with training stimuli and accuracy during real-world scent-matching operations.

It is well established that dogs can learn to reliably smell the human scent on a scent sample and then choose from among alternatives the alternative that matches the scent sample [1–10]. However, under appropriately controlled MTS conditions, many dogs fail human scent-matching tests. When testing involves constraints to control against alternative solutions, it is not uncommon to find dogs that have not learned to scent-match, even though it was firmly believed from their training they had successfully learned to use the scent sample as a signaling cue. The question is, why do some dogs learn to scent-match while other dogs fail?

Primarily, the solutions scent-matching dogs can learn during MTS conditional discrimination training can be divided into two categories; associative solutions that are training stimulus bound or a relational solution that can transcend training stimuli. Dogs can learn sample-specific associative chains with training stimuli, in which associations are formed between each specific scent sample, correct choice, and reinforcement, or dogs can learn about the matching relationship common to all trials between the scent sample and matching comparison [11]. Both are MTS conditional discrimination solutions in which the scent sample is used as a conditional cue to signal which discriminative stimulus is correct on any given trial. However, of the two, only the relational solution enables dogs to scent-match during operations when choice alternatives are novel. Furthermore, in systematic pseudo matching-to-sample (pseudo-MTS), solutions can be subdivided into simple discrimination, in which the sample stimulus is not used as

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a signaling cue, and conditional discrimination, in which the sample stimulus is used. During pseudo-MTS, in which simple discrimination solutions are not controlled against, dogs can form direct associations between discriminative stimuli that are systematically correlated with reinforcement, at the expense of learning to use the scent sample as a signaling cue or learning about the matching relationship between the scent sample and matching comparison.

Because associative learning requires prior experience to learn about the predictive relationship between cause and effect events, dogs that have learned associative solutions cannot accurately and reliably respond during operations when human scents to be matched and discriminated between are novel. Alternatively, a more complex cognitive achievement involves learning the matching concept, that over trials the correct choice is always the *same-as* the individual-unique information on the scent sample. Dogs that have learned about the matching relationship common to all trials can respond as accurately during scent-matching operations when matching and nonmatching human scents are novel as they can with training stimuli.

The earliest scientific reports involving systematic pseudo-MTS and random control MTS conditional discrimination procedures were in the late 1700s when Itard initially used a pseudo-MTS procedure to teach stimulus-matching to Victor, the wild boy of Aveyron. Once Victor reached performance criterion, subsequent tests revealed he ignored the sample stimuli and did not learn about the matching relationship from the pseudo-MTS arrangement in which presentation position of alternative stimuli were not varied over trials. Yet, when the arrangement was changed to MTS, Victor learned to use the sample stimuli as signaling cues and succeeded in learning a MTS solution strategy [12].

Instructions of stimulus-matching tasks, to choose the comparison that matches the sample, sound so simple that it is difficult to imagine learning a matching solution could pose a problem. However, when Itard used a pseudo-MTS procedure to teach stimulus-matching to a feral boy, Victor learned the systematic stimulus presentation position solution that was not controlled against in the pseudo-MTS arrangement. Furthermore, although Victor succeeded in learning to use the sample stimuli as signaling cues and learned a matching solution from the subsequent MTS procedure, Itard reported it was substantially more difficult for Victor to acquire than the alternative solution not controlled against in the initial pseudo-MTS arrangement.

In a more recent study, Ono et al. [13] examined whether sample stimuli would acquire a signaling function based on the stimulus-stimulus pairing between the sample and matching comparison in a pseudo-MTS procedure and whether the function of sample stimuli differed between humans and pigeons. In their pseudo-MTS procedure, when sample stimulus S1 was presented, the choice alternatives were C1 correct and C2 incorrect over trials. When sample S2 was presented, the alternatives were C3 correct and C4 incorrect. Thus, rather than use the sample stimuli as a signaling cues, subjects could learn two simple discrimination solutions between C1+ predicting reinforcement and C2− predicting the omission of reinforcement and between C3+ predicting reinforcement and C4− predicting the omission of reinforcement. Once undergraduate students and pigeons reached criterion, both groups were tested to determine the solution strategy learned. The results showed that only humans learned to use the sample stimuli as signaling cues. Humans learned both a relational matching solution and the simple discrimination solutions, whereas the pigeons' response performance were affected solely by the simple discrimination reinforcement contingencies inherent in the pseudo-MTS procedure.

Very little scientific research has been conducted to investigate canine human-scent-matching training. Moreover, the solution strategy that human-scent-matching dogs must learn to perform accurately and reliably during operations has not been reviewed in any scientific journals. Additionally, although mantrailing and lineup detection dogs are often termed scent-specific, to date canine human-scent-matching literature has not distinguished between simple discrimination, random control MTS conditional discrimination, and systematic pseudo-MTS procedures. Thus, rather than, or in addition to, training with the MTS conditional discrimination procedure developed to meet scientific standards of objectivity, canine human-scent-matching training typically involves pseudo-MTS procedures developed by dog trainers who lack scientific methodology. In systematic pseudo-MTS procedures, simple discrimination solutions are not controlled against. Thus, although dogs may be scent-specific in that they discriminate between alternatives, unless training involves MTS in which reinforcement is contingent upon use of the sample stimulus, dogs may not learn to use the scent sample as a signaling cue and may not learn about the matching relationship.

Therefore, the primary purpose of this paper is to examine the evidence to determine whether dogs learn to use the scent sample as a signaling cue and learn a scent-matching solution strategy from systematic pseudo-MTS training arrangements. However, because the solution strategy that human scent-matching dogs must learn to perform accurately and reliably during operations has never been reviewed, a brief history to acquaint readers of the issues will be helpful. Also, to help resolve some key training obstacles, additional MTS guidelines that comparative learning and cognition researcher have found can enhance novel stimulus transfer performance will be briefly reviewed.

1.1. The history of canine human-scent-matching

The first examples of scent-matching failure became evident in the early 1900s. Following the publication of George J. Romanes' book, – Animal Intelligence – in 1882 [14], reports involving exceptional feats of animal intelligence rapidly became popular among the public. So much so that his book, based on anecdotal evidence and ejective inference, marks the beginning of the field of comparative psychology. Remarkable stories of animal intelligence were so inspiring that a few years later when Romanes [15] wrote about tracking experiments he conducted with his setter, the paper not only prompted wide spread use of police tracking dogs, it also became popular to use police dogs as detectives to identify suspects in homicide cases. Accounts of extraordinary achievements involving scent-matching tracking dogs helped to quickly popularize their use worldwide. However, it soon became evident that convictions based on canine scent-matching evidence were highly questionable. Between 1913 and 1914 the popularity of scent-matching police dogs began to give way to much controversy when the results from several types of highly-controlled scent-matching tests conducted by Prussian officials revealed that police tracking and lineup detection dogs from around the country did not scent-match [16].

1.2. Prussian tests

The objective during canine human-scent-matching testing is to determine whether dogs will reliably smell the novel human scent on a scent sample, compare the memory of that scent to two or more novel alternatives, then choose the comparison that matches the human scent on the previously presented scent sample. Therefore, scent-matching tests require more than just double-blind controls against cueing from the handler and testers. Tests need controls against all potential alternative solutions. Specifically, test trials require random control MTS conditional