REFERENCE DOCUMENT 3

ANALYSIS PHASE IN MEDDS AND REST[1]

For the sake of brevity, I will describe here only those procedural differences that are most apparent in analysis phases between two organisations: Mechem and Norwegian People's Aid (NPA). We will also describe some recent research and development work on analysis phases conducted by the Belgian APOPO organisation and Swedish Rescue Services Agency (SRSA). A lot of important details regarding an organisation's analysis procedures appear in their SOPs because the accuracy and reliability of the animals depend so heavily on the details involved in this phase.

Rest analysis

Mechem

With their Explosive and Drug Detection System (MEDDS), Mechem use a dedicated building for the analysis phase. This building is maintained like a laboratory and various measures ensure that the building remains uncontaminated by even tiny traces of explosives. Between 10 and 12 stands are placed at 1 to 1.5m intervals against a long and solid wall inside the building. At one end of the wall, solid screens obstruct a view between a dog-holding area and the set of stands. Each stand supports a filter cartridge around nose height for the dog. One dog at a time is led on a short lead from the holding area and past the ten or so stands. The lead is always kept slack and dogs are given time to sniff at each filter and perhaps sit afterward. The consequences delivered to the dog for sitting at a stand depend on exactly what type of filter was loaded there.

[1] This document was drafted by Dr Brent Maxwell Jones, Associate Professor (Research), Behavioral Technology Group, E.K. Shriver Center, University of Massachusetts, Medical School, Waltham, USA.

At times, training filters of known assignment are loaded into stands. Sitting next to stands that contain positive training filters occasionally earns the dog an opportunity to chase a tennis ball thrown by the handler. In contrast, sitting at stands containing either negative training filters or operational filters are never rewarded: a dog is simply led away back to the holding area after sitting for between one and three seconds. Exactly when training or operational filters are presented on stands is varied systematically, to be unpredictable by the dog.

Every day of operational work begins with a set number of training filters with which a dog's accuracy and readiness for inspection of operational filters is assessed. (For example, 40 training filters consisting of 35 negatives and five positives might be presented in four runs of ten filters.) If a dog's accuracy on these runs (measured in terms of a minimum hit rate and a maximum false-alarm rate) exceeds a pre-set criterion, the dog is used for operational work that day. Further positive training filters are then interspersed quasi-randomly between operational filters in the remainder of the work session.

Runs on which an operational filter has been replaced with a positive training filter are known as *motivation runs*. The aim of arranging these runs is to maintain searching for, and subsequent detection of, the target odour on operational filters in the absence of rewards on those operational filters. It is extremely important, therefore, that the odours on positive training filters are not categorically different from the odours on operational filters. To disguise the difference between these odours, operational filters previously rejected by dogs (and thus are very likely to be negative) will have the odour of explosive compounds (TNT and DNT) laid over them. Mechem achieve this by drawing air from a cardboard box containing a tiny amount of TNT (a so-called vapour strip) over a filter that has previously been collected in the field.

Mechem usually operate their dogs in pairs where one searches a set of ten filters (training or operational) immediately after the other. This minimises the handling of filters and so minimises the risk of adding extra odour cues to filters, and allows a comparison of each dog's responses toward particular filters. Operational filters are deemed to be positive – and so worthy of follow-up in the field – if either dog sat next to it (i.e. indicated it). Consequently, operational filters are considered negative only if neither dog indicated it. The daily assessment of accuracy with training filters, combined with this definition of negative filters, is expected to keep the rate at which the system misses mines at a very low level.

NPA

NPA took a different approach in the analysis phase when they were using Remote Explosive Scent Tracing (REST) on roads in Angola. The procedure used later in their Angola work was shaped largely by a consultant from Norsk Kompetansesenter for Spesialsokshund AS (NOKSH AS) in Norway. The procedure involved presenting filter cartridges on a device known as a *carousel* (or *Apparatus for Discrimination of Source Material*). On this device, filters were clipped at the ends of each of 12 arms that extended from a central hub much like spokes on a wheel. This carousel sat in a laboratory room about 60cm above the floor so that the filters were at about the height of a dog's nose. An axle was fitted between the hub of the carousel and a base that supported the unit, allowing the arms to be spun. This spinning allowed quick and easy repositioning of filters relative to the internal features of the room, a routine that was performed regularly in training and operational sessions to remove any position cues. Dogs were trained to examine each filter on the carousel in a counter-clockwise direction and while being off a leash.

NPA required each set of 12 operational filters to be examined by at least three dogs. In addition, each dog was required to examine each set of filters twice. Therefore, each filter was examined a minimum of six times. The procedure went as follows. A technician would begin by placing filters at each arm of the carousel. A dog would then be led into the room and commanded to search the carousel. Between each visit to the room and carousel search, the carousel was rotated to move the filters a variable but known distance. Consequently, if the dog sat after sniffing a filter on the first occasion it encountered that filter, then it would be led from its seated position out of the room, and the position of that suspect-positive filter would be changed for the second search. If the dog indicated that filter on the second search also, then the dog is removed from the room, and the filter is removed from the carousel and replaced with another.

If filters remain to be examined a second time, then the dog is brought back into the room to search those remaining. Otherwise, a second dog starts searching that set of 12 filters (minus any indicated by the first dog). Those filters indicated by the first dog are temporarily put aside and later inserted between filters in positions with which the dog handler is unaware. If they are indicated by a second and/or a third dog, or indeed both, then greater confidence in the accuracy of the dogs develops. However, any filters that were indicated at least once and by at least one dog were considered positive filters and were followed-up by field operators.

As with Mechem, NPA also refrained from rewarding indications on operational filters, preferring instead to periodically insert training filters (of known assignment) between operational ones, and reward intermittently hits on training filters. Their procedure also meant minimal handling of filters and so less risk of adding odour cues for the dogs. Unlike Mechem's procedure, however, NPA started constructing training filters using methods similar to those used in the sampling phase. That is, they would make positive filters by having their sampling teams use their vacuum pumps while walking over an area that contained at least one mine that they themselves buried and defuzed earlier. By using this method, training filters would likely be very similar to operational ones, and the dogs might have received training to indicate odours other than just those emanating from the explosive contents of mines (e.g. the odour of plastic casings or rubber seals).

APOPO and SRSA

Recent research by APOPO and SRSA has been pursuing the development of effective and efficient methods of analysis in REST systems. Experimental psychologists (trained in applied behaviour analysis and familiar with the research literature on learning in animals) have attempted to validate empirically the various components of the analysis procedures used by Mechem and NPA. This validation process involves conducting carefully-controlled experiments where a single procedural feature is isolated as the sole difference between conditions being compared.

A large number of procedural differences turned out to be trivial, in so far as they had little effect on an animal's detection accuracy. But various other differences had significant and reliable effects on the animals' accuracy. The research has attempted to identify variables that (if left uncontrolled) will produce variance in an animal's detection accuracy, and to identify methods for assessing whether the animals are discriminating positive from negative samples using the cues that trainers intend them to use.

A notable feature of SRSA's model for analysing operational samples is that rewards are provided intermittently and at a high rate on both operational and training samples. The system they propose for this has been called *reinforcement for agreement*. As the name suggests, this involves rewarding an animal's indication response on an operational sample if it agrees with the response to that sample made by a previous animal. The principle is that if each animal's hit rate is high, then its false-alarm rate is low; and if its false alarms are independent of the other animal's false alarms, then the probability of rewarding an error on operational samples in the second dog is very low. Being able to reward indications on operational samples as well as on training samples reduces the likelihood of animals learning to discriminate between the two sample types, and so keeps detection accuracies on operational samples high.