MASTER'S THESIS

Learning in Complex Systems

June 2018

Different Discrimination Procedures and Affecting Variables

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I would like to express my sincerest gratitude and appreciation to Per Holth and Eva Berttilson for their help and guidance through the process of writing my master thesis. I would also like to thank the staff and workers at Kristiansand Zoo and Sötåsen naturbruksgymnasium, for letting me work with their animals and use their facility.

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Variables Affecting Discrimination Training: A Review

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Abstract

Animals and humans discriminate between stimuli everyday through the process of differential reinforcement. When one aspect of a stimulus response is reinforced in the presence of stimuli with specific properties extinguished in their absence, the organism learns to respond to stimuli with those properties and not in their absence. There are two main types of procedures used for teaching discrimination (Catania, 2013). These two procedures work entirely on reinforcement and extinction. There are other procedures that combine reinforcement and extinction with both negative reinforcement and punishment, such as errorless learning (Arantes & Machado, 2011) and learning with correction (Armus, Montgomery & Gurney, 2006). Other procedures that uses prompts (Cooper, Heron, & Heward, 2007) or Matching-to-sample procedures are other alternatives (Steingrímsdóttir & Arntzen, 2011). With all of these procedures there are a lot of variables and behavioral effects needed to be addressed when researching discriminative learning and/ or, using discrimination procedures (Skinner, 1938). The subject of discrimination is very wide and include a lot of variable that all aims to give a better understanding of the subject of discrimination and discrimination procedures. This paper is a brief review of some of the available research and it aims give a better understanding of the subject of discrimination and discrimination procedure as well as looking at some behavioral consequences and affecting variables.

Keywords: Discrimination, Simultaneous, Successive, Discrimination procedures

Variables Affecting Discrimination Training: A Review

All organisms learn to discriminate between different stimuli. They learn to discriminate between objects, colors, signs, individuals, situations, different antecedents and much more through the process of discrimination. Discrimination happens when a behavior is differentially reinforced in the presence of a specific stimulus, or stimulus with specific properties. It is the process in which an organism learns the difference between two or more stimuli. Some discriminations may only be effective under certain condition and are therefore conditional discriminations while others are simple (Catania, 2013). A stimulus may be visual or verbal, it can be olfactory or auditory, or it can be tactile. Discrimination procedures are used in applied setting with both human and animals to teach a variety of skills, or in experimental settings to gain insight into the process of learning and to investigate for instance sensory capacities, cognitive functions (Skinner, 1938). For example, it can be used with humans to teach academic skills to children (Arntzen, Lian & Halstadtrø, 2011) or to diagnose and treat patients with dementia (Steingrímsdóttir & Arntzen, 2011). It can be used with animals to teach for example communication skills. Horses have been taught to communicate blanket preference during different weather conditions (Mejdell, Jørgensen & Bøe, 2016), pigeons and honeybees can be trained to discriminate between colors (Skinner, 1938: Dyer & Neumeyer, 2005), dogs and rats are trained to discriminate different olfactory stimuli, making them capable of finding a variety of substances, such as explosives, drugs and even earth corrosion (Schoon, Fjellanger, Kjeldsen & Goss, 2014; Richelle, 2016). Research focusing on teaching discrimination to both humans and animals has been done using both simultaneous and successive discrimination procedures. Both have proven effective, however there is little research exploring the basic differences between the two (Bitterman, Tyler, & Elam, 1955). This will be discussed later in the paper.

The purpose of this paper is to provide an overview of literature and research done on the topic of discrimination and it´s use in both experimental and applied settings. It will give a brief overview of the subject, the different discrimination procedures and the characteristics of the discrimination they produce. It will discuss different aspects of the discrimination term in general, it´s application, consequences and its usefulness when working with both humans and animals, in experimental and applied settings. Although studies and research done with both human participants and animal subjects, the main focus here will be on those with animal subjects.

Discrimination in general

The term discrimination in layman´s terms is often thought to refer to treating people differently, based on distinguishing features such as race, gender, disabilities etc. However, in behavior analysis the term refers to the ability to learn to respond differently to different stimuli, possibly in different situations or settings. In other words, learning which stimuli signal reinforcement in a given situation. One definition defines discrimination as "*Any difference in responding in the presence of different stimuli*" (Catania, 2013 p 438), and adds that it involves differential reinforcement of some properties of the response. This means that there is a difference in the response based on differential consequences that occur in the presence of different stimuli, or that the response is differentially reinforced. All organisms discriminate between different stimuli, based on their relevance to whether or not reinforcement is available. There are two kinds of discriminations, simple and conditional. A simple discrimination is based on the three term contingency SD:R –SR, while a conditional discrimination is based on the four term contingency SK (S^D-R–S^R) under control of the S^K. In classical conditioning, it is referred to as the ability to distinguish between a conditioned stimulus and other meaningless stimuli that do not signal an unconditioned stimulus (Catania, 2013).

According to Bogale & Sugita (2014) the subject of discriminative learning, especially in animals, hasn't been regarded as anything more than unavoidable or, of no importance. It has been studied in relation to, or as a comparison to the process of learning in humans and widely used to investigate sensory capacities in different species. Newer research is now investigating how animals learn to discriminate between stimuli, both simple and complex, if they can categorize stimuli and if they are able to form concepts (Bogale & Sugita, 2014). Researchers are also looking at how this knowledge can be applied in both in a scientific experimental setting, and applied settings, such as in animal husbandry. Other aspects that have previously been investigated are the behavioral phenomena that appear during and after exposing an organism to a discrimination procedure, and the behavior characteristics of the pre and post solution period of learning, such as the response position habits, spontaneous recovery and extinction (Spencer & Langfeld, 1936)

One of the first to review the term and explain the process of discrimination was B. F Skinner in The Behavior of Organisms (1938). He defined it as the process where an organism learns to respond to specific aspects of a stimulus and not respond to another similar stimulus. He refer to it as being a combination of reinforcement and extinction operating together, strengthening or weakening the eliciting tendencies of a stimulus. This creates the conditioning of some stimulus aspects and extinguishes others. It´s a process that happens everywhere all the time. One of the more famous examples, as refed to by Skinner (1938), are Pavlov´s experiments where he conditioned the excretion of saliva in dogs upon the sound of a bell. The sound of that specific bell went through the process of conditional discrimination and would elicit the secretion of saliva whenever played (Skinner,1938).

Skinners work on discrimination and the usage of his experimental box, the operant chamber, are part of the foundation of how discrimination is being studied and used today in experimental settings. His operant chambers and methods are still being used and provide a way of controlling the experimental environment when doing research on for instance, sensory capacities, cognitive functions or stimulus generalization. Watanabe, Sakamoto & Wakita (1995) used an operant chamber to teach pigeons to discriminate between paintings done by either Monte, Picasso and two other artists, to find out if they could discriminate between different artist, and whether there was any generalization effect. They subjected the birds to two similar experiments, using simultaneous discrimination. Experiment one was using non-arbitrary stimuli while experiment 2 used arbitrary stimuli. The results demonstrated that the animals' behavior came under stimulus control and all animals successfully learned to discriminate between the artists. They also found that birds showed some generalization to novel paintings and other impressionists based on which artist they were trained to discriminate. However, there was no statistical difference between the rate of discrimination learning between the two experiments with non-arbitrary and arbitrary (Watanabe et al, 1995).

Watanabe (2001) replicated the study from 1995 based on art discrimination, also adding a human participant group. They compared discrimination learning in humans and pigeons to see if there were any significant differences, also looking at differences in the generalization effect of the procedure with the human participants. The results of both experiments were consistent with the previous study showing that pigeons are just as capable as humans to discriminate between artists. It also indicates that both humans and pigeons have a high visual cognition. Also, the human subjects showed a complete generalization of the discrimination after training (Watanabe, 1995).

The process of discrimination is universally the same and applies to all organisms. In experimental settings it is easier to investigate and use discrimination procedures compared to in an applied setting because it allows for a more controlled environment. One big difference between the two settings is that the experimental procedure and data recording in an experimental setting is often recorded automatically through automatic systems. In applied setting the experimental procedure and data recordings are often done hands on with fewer automatic systems to help register and record. This means that it may be more prone to bias and mistakes that might occur when working in a hands-on situation with an animal or another human. This is especially challenging when working with animals because there might be differences in how the procedure is done and what data will be recorded because people often don't see the same thing, which might cause differences in the recordings that again creates indiscrepancies in the data and results (Skinner, 1938).

Two main types of discrimination procedures

There is a lot of research being done in both experimental and applied setting in relation to discrimination learning and discrimination procedures. Most of the research in recent years on the subject of discrimination has been done with rats, pigeons, primates and humans, where the main focus has been on discrimination in general or in relation to other subjects mentioned earlier (Watanabe et al, 1995; Watanabe 2001; Steingrímsdóttir & Arntzen, 2011). It seems that few studies have focused specifically on the basics principles of the discrimination procedures, such as the simultaneous and successive procedure (Loess et al, 1952)

However, current literature refers to two main types of discrimination, simultaneous and successive. Both can be either simple or conditional and are referred to as the two main procedures for discrimination training (Catania, 2013). Simultaneous discrimination refers to a type of discrimination where a subject learns to differentiate between two or more stimuli that are presented at the same time. This type of discrimination will always give the subject the opportunity to earn a reinforcer in each trail when responding to the correct stimulus. The successive discrimination is a type of discrimination, where two or more stimuli are presented one at a time. This means that the subject will only have a chance to earn reinforcers in the presence of the stimuli defined as the S^D and not in the present of the S^Δ. Successive procedure are also sometimes called go-no go discrimination for that reason. Both types of discrimination can be used separately or in combination (Bitterman, Tyler & Elam, 1955)

A conventional procedure for stimulus discrimination training demands one behavior and minimum two antecedent stimulus conditions, S^D and S^Δ, and a response will only be reinforced when given as a response to the S^D. Responses to the S^Δwill be ignored. This is the foundation of stimulus discrimination and how the two types, successive and simultaneous discrimination, work. The terms simultaneous and successive comes from the fact that the two types of discrimination involve two different arrangement of stimulus presentations. The main difference between the two procedures is the fact that the sample S^D and $S^\Delta$are either presented at the same time, or one by one. During a successive discrimination, the sample S^D and $S^\Delta$are presented one at the time meaning that not every presentation of a sample may lead to reinforcement, but only the responses occurring will the S^D is present will be reinforced. During simultaneous discrimination, the sample S^D and $S^\Delta$are presented at the same time, meaning there will always be the possibility of a response being reinforced (Bitterman, Wodinsky & Pratt, 1953).

Most research on discrimination learning and discrimination procedures investigates it in relation to other topics such as sensory capacities, cognition etc. Not many studies focus on the basic functions of the two procedures, and the effects they have when used combined or alone. According to most literature and research it is not common to train discrimination only by using one of the two types. The training is often done with combination of the two procedures. This is done either by starting up with successive discrimination during pre-training before switching to simultaneous discrimination or vice versa (Spencer & Langfeld, 1936). An example of this is Mejdell, Jørgensen & Bøe (2016) on blanket preferences in horses. In the experiment the horses were first subjected to a successive discrimination procedure to establish each symbol independently before switching to a successive procedure to create the free choice situation where the horses choose the preferred choice (Mejdell et al, 2016).

There are few recent research studies that focus on a pure comparison of the two main procedures for discrimination. Most of the articles that can be found on this specific subject indicate that simultaneous discrimination is easier to master than successive, and that those individual exposed to the simultaneous procedure do better than those subjected to the successive procedure. For instance, Dyer & Neumeyer (2005) found that honeybees were significantly better at discriminating color simultaneously than successively. The bees had a 73,1 % mean frequency of correct choices in simultaneous procedure compared to 62,8% in in successive when trained to discriminate yellow. Bitterman et al (1953 &1955) also referred to similar results with rats in and a conventional jumping apparatus, indicating that the simultaneous procedure is easier for the subject to master than successive (Loess, Duncan & Melton, 1952).

One study that specifically looked into a comparison of the two procedures discrimination was Loess et al (1952). Their study investigated discrimination learning in humans and did a pure comparison between the two procedures, looking at the differences in rate of learning between the experimental groups. They hypothesized that the amount off comparison opportunities in the procedures would affect the rate of discrimination learning. Based on that they argued that the simultaneous procedure would have a faster rate of discrimination learning than successive. The two procedures were divided into either an easy or a difficult discrimination. Two groups were subjected to either a simultaneous or a successive discrimination procedure and trained to discriminate between two sets of stimulus cards. During the easy simultaneous procedure two sample cards were presented at the same time and during the difficult three cards sample cards were presented. Their results show that when comparing the easy procedure there was no significant difference. However, when comparing the difficult procedures, the simultaneous procedure had a faster learning rate than the successive discrimination training procedure (Loess et al, 1952).

A research review by Lipsitt (1961) on the subject of comparing simultaneous and successive discrimination in children refers to similar results as indicated by Bitterman et al (1953), Dyer et al (2005) and several other studies. All relevant experiments reviewed by Lipsitt (1996) in general showed that when comparing two simple procedures, the simultaneous procedure resulted in better discrimination learning and faster average learning rate than successive procedure. This means that the subjects solved the discrimination problem with fewer repetition and with more accuracy during the simultaneous than successive procedure. However, the review also notes that this was only the case long as the procedure required the subject to orient or move directly towards the stimulus complex containing the stimulus cue. If the subject was required to respond to a locus removed from the stimulus source it was more likely that the two procedures produced equal outcomes, or that the successive procedure would yield better discrimination learnings. This indicates that as long as the procedure are relatively simple, requiring a response directly on the stimulus source or that there is a big difference between stimuli, the simultaneous procedure is easier. When the procedure gets more complex, requiring a response other than at the stimulus source, or the stimuli get to similar, the successive procedure becomes equally easy or easier compared to simultaneous. Put differently the review concludes that the ease of the procedures depends on what type of response is required and the how great the similarity of the stimulus is (Lipsitt, 1961).

According to Bitterman, et. al (1955) there are four major influencing variables that affect the relative difficulty of the two types of discrimination; Contact, contiguity, set and stimulus similarity. Contact and contiguity have so far not been systematically separated and are often studied simultaneously, looking at their joint influence. All four variables can be studied and compared under two sets of conditions; the component conditions and the configurational conditions. Under the component conditions the subject is required respond with a direct contact to the stimulus presented, by approaching it directly. This means that the subject learns to directly approach the correct stimulus and avoid the wrong one. In the configurational conditions however, the subject is required to respond with no direct contact with the stimulus but with an alternative response such as jumping to the right or to the left of the stimulus. When Bitterman et al (1955) compared these two conditions he found that the simultaneous- component problems gave easier discrimination than the successive condition problems. However, during the configurational conditions the successive problems became easier than the simultaneous. This corresponds with findings from other studies, mentioned earlier (Lipsitt, 1961; Dyer et al 2005) saying that long as the discrimination is simple and demands a response directly to the stimulus source the simultaneous procedure is easier. When the discrimination becomes more complex and demands a response to a locus removed from the stimulus source the successive procedure becomes easier than the simultaneous (Bitterman et al, 1955).

A brief overview of other procedures

As mentioned there are two procedures considered to be the main procedures for training and studying discrimination learning. However, there are a couple of other procedures that are applicable for both experimental and applied settings. Some of the difference between the two main and other procedures is that they contain pure simultaneous or successive presentation of stimuli and positive reinforcement. Some of the other procedures, that will now be briefly mentioned, are often a combination of both and may contain other elements such as negative reinforcement or punishment, fading or prompts as a part of the procedure (Catania, 2013).

Matching –to –sample procedure, MTS, is one of the most common procedures used in applied settings. It was first introduced by B. F. Skinner through his work with pigeons. In his experiments, the pigeon was trained to peck on the screen to activate a colored light. Pecking on the light would activate two or more comparison stimuli. Pecking the sample colored light would produce reinforcer (Skinner, 1938; Skinner, 1950). MTS is now used in a variety of settings, such as with children in school, or with disabled or elderly people. For instance, MTS is a conditioned discrimination procedure that can be used as method to identify early onset of dementia and help differentiate between different types. During an MTS procedure a human subject is first successively presented with a sample stimulus, followed by two or more comparison stimuli presented simultaneously. A response to the correct comparison is rewarded while an incorrect response gives a timeout or a wrong response prompt. The comparison stimulus can be either identical or arbitrary and it can be presented either simultaneously or with a time delay DMTS. (Steingrímsdóttir & Arntzen, 2011).

An MTS procedure can have three different trainings structures, linear structure, LS, one-to-many, OTM, and many-to-one, MTO. In a linear structure the comparison stimuli for the first relation are the sample comparison stimuli for the second relation, meaning they functions as a node between the two. An MTO structure has one set of comparison stimuli, which functions as a node, after the sample. So, the stimulus relationship is from many samples to one set comparisons. An OTM structure has one sample stimuli that functions as a node but before the comparisons, which means that the relation is from one set of samples to two or more sets of comparisons (Arntzen et al, 2011)

Errorless learning is a procedure that increases the likelihood that learning occurs with few or no incorrect response by using fading as a part of the procedure. The subject is first conditioned to respond to the sample before adding the comparison stimuli, making it less likely that the subject chooses the incorrect sample. The comparison stimuli can be faded in or out (Arantes & Machado, 2011). For instance, pigeons were first exposed only to the red color and pecking was reinforced. When the red color is established as the S^D, the comparison stimuli or S^Δ is added. This is done by alternating between the red light and another stimulus, which is not reinforced. The other stimulus might differ in wavelength, duration or brightness which is gradually changed until it becomes the desired comparison stimulus, before being presented at an equal duration as the S^D. The results of Terrace (1963) show that that pigeons can acquire operant discrimination with few, or no, incorrect responses by fading the in S^Δ. Terrace (1963) concluded that the formation of discrimination is affected by how the S^Δ is introduced and that this will affect how many responses to S^Δ will be made. In a conventional trial and error procedure the subjects will have a higher number of responses to the S^Δ compared to an errorless learning procedure (Terrace, 1963).

Discrimination procedure with response prompts are mostly used with humans, especially disabled individuals. There are three kinds of response prompts available; verbal instruction, modelling and physical guidance. Verbal instruction, can be vocal or non-vocal, and it involves a verbal instruction of what to do, either by saying the instruction or shoving it in writing. Modelling means showing the subject what to do. Physical guidance, means to physically guide the subjects' movements through the entire movement of the response (Cooper et al, 2007). When using any of the three kinds of prompts just mentioned, there are four procedures available; Most-to-least prompt, least-to-most prompts, graduated guidance and time delay. Most- to-least prompts mean to give a lot of guidance in the beginning, decreasing it when the subject progresses, normally that means from physical guidance to verbal or visual prompts and finally to the natural stimulus. Graduated guidance means following the subjects' movement without touching and increasing the distance when the subject is progressing. Least-to- most prompts mean to increase the amount of guidance if the subject is not preforming as well. It starts with no guidance and if the subject fails help is increased through the use of visual or verbal cues before using physical guidance as a last option. The time delay uses the effect of variation in time between the presentation of the natural stimulus and the response prompt. The delay, either constant or progressive, helps transfers stimulus control from a prompt over to the natural stimulus (Cooper et al, 2007; Catania, 2013).

There are two variants of discrimination with correction. The first variant involves punishment for any response to the S^{Δ}. It can be in the form of anything unpleasant that that decreases the chance of the subject making the same response again. For instance, Dyer et al, (2005) studied color discrimination and compared procedures in honeybees. During training the bees would be rewarded with a drop of water containing either 25% sugar or 0,12% quinine salt.

If the responded to the correct color they would get the sugar water. If they chose the distractor color they would get the salt water functioning as an aversive stimulus A variant involves creating escape and avoidance response to the S^{Δ}. An example of this kind of procedure involved training single celled organism, paramecia, using electroshock to discriminate brightness of light. The subject was given an electric shock whenever responding to the S^{Δ}. The results showed that discrimination learning could be acquired through the use of an aversive. However, the avoidance behavior was quickly extinguished when shock was no longer delivered, indicating that this more research is needed to conclude on whether or not discrimination learning has actually taken place (Armus, Montgomery & Gurney, 2006).

Affecting variables and behavioral consequences of discrimination procedures

When working with any organisms there are affecting variables and behavioral consequences to consider when subjecting them to discrimination problems. Attention (Reynolds, 1961), previous learning history, how the training is set up, the setting, interference in reinforcement schedule, Clever Hans syndrome (Heinzen, et al. 2015) and many others might be variables that can affect discrimination learning. Sometimes the experiment or training itself might also have behavioral consequences such as position response, extinction related behavior such as aggression, frustration, stereotypic behavior etc (Cooper, et al, 2007; Catania, 2013). These should be considered before subjecting an animal or human to a discrimination procedure. Some of these variables will now be further discussed.

One of the first thing to consider is the subjects previous learning history. If the subject has a previous history of being trained in a similar way to how the discrimination procedures is set up it needs to be taken into consideration because it might already have an association to what the correct response might be, this might give a faster rate of learning compared to a subject with no previous history. This is one of the reasons experimental research require naive animals(Skinner,1950)

When subjecting an organism to any training procedure or experiment, including discrimination, environmental disturbances can affect the outcome of the procedure. For instance, it might delay or stop learning. Garbor & Gerken (2010) trained horses to solve matching-to-sample problems in their natural environment. They found that training was affected by several external factors such as tractors, people and dogs. All of which created startling responses in the horses and affected the training by delaying it. Environmental disturbances are not easy to control in applied settings. This means that the environment needs to be thoroughly investigated, looking for possible disturbing factors before starting the experiment (Garbor & Gerken, 2010).

In a procedure or experiment the relationship between an aspect or part of the environment and the response, also known as attention, might affect the consistency of response. An organism will attend to an aspect in the environment that through variation and elimination of that aspect ends up eliciting a variation in the organisms behavior. So, an aspect of a stimuli correlating with the reinforcement might end up eliciting the behavior instead of the intended stimuli. This might be a noise or might be the background the stimulus is presented on etc. Reynolds (1961) tested attention in pigeons and found that the birds “may attend only to one of several aspects of a discriminative stimulus” (Reynolds ,1961. p 208). He found that when two pigeons were exposed to a superimposed triangle on a red key, one attended to the triangle while the other attended to the red key. A second pair were exposed to white figure on a colored key and different colored lamps. It was reviled that the birds did not attend to the color of the light but their response was under control of the presence or absence of the yellow side lamp.

When working with animals evaluating which S^D they actually respond to can be tricky. Often they look at the human for clues on what to do. In an experimental or automatic setting this is not an issue because the subject is not able to see the experimenter. However, in an applied setting the animal is almost always able to see the experimenter and will look at body language for clues. This means that the animal might responds to a different S^D then the one defined as the correct one. In other word it´s a false positive discrimination learning. The animal has not leaned to discriminate between the samples but leaned to look at the body language for clues. Often animals are looking at our body language and respond based that rather than the intended S^D. This is what's known as the Clever Hans syndrome. A horse known as Clever Hans was thought to have the ability to understand and solve puzzles. It was discovered that he was in fact responding to body language rather than actually solving the problem with cognitive processing and understanding. Because animals are so sensitive to human body language it is something that needs to be taken into consideration when working in an applied setting since it will always be an affecting variable as long as there is direct interaction between the subject and the experimenter. (Heinzen, Lilienfeld & Nolan, 2015)

Clever Hans Syndrome can be countered, making it less likely to occur. One option is to automate the procedure as much as possible so that direct interaction between subject and experimenter is as brief as possible. Less direct contact during the procedure makes the subject less dependent on looking at the experimenter for clues. Another possibility would be to put up a barrier so that the animal can´t see the experimenter while working. If direct contact is needed at all times there should be specific guidelines for how the experimenter are supposed to behave and how they should control their body language to ensure that the animal won´t be able to depend on that for clues. A good example of this is when experimenters, working with Clever Hans started controlling their body language. They found that Clever Hans was tapping his hoofs based on a head tilt from the experimenter and the question asked. When the experimenter controlled this the horse´s performance dropped considerably and he made more errors. The horse would tap his hoof when the head tilted forward and would continue until the head tilted back up. Another option might also be switching between experimenters during procedure if the subject is not affected by it (Heinzen, et al. 2015)

Overshadowing is “an attenuation of respondent conditioning with one stimulus because of the presence of another stimulus” (Catania, 2013. p 454) If two or more conditioned stimuli iare simultaneously presented, one being more salient than the other, that one ends up overshadowing it when both are paired with the same unconditioned stimuli. For instance, when a bell and a tone is presented simultaneously preceding food, the tone might remain ineffective as a conditioned stimulus even though they were presented together. In blocking, one stimulus is interfering because one of the stimuli is already established as a conditioned stimulus. The novel stimulus cannot become a conditioned stimulus due to the prior the already established. For instance, if the bell is already established as a conditioned stimulus the bell will remain ineffective even if they are presented together. So, overshadowing has to do with which stimulus is the most salient. The most salient stimulus will become the conditioned stimulus and the other will be ignored. Blocking on the other hand is about experience with already established stimuli (Catania, 2013) Both overshadowing and blocking can affect the discrimination procedure by stopping or hindering the formation of the correct conditioned stimuli. If one signal is already established as a conditioned stimulus it might block the creation of the new one or if two signals are simultaneously presented it might cause the wrong signals to elicit the response. When subjecting an animal to a procedure the signals used in the procedure should be novel and not one the animal already has experienced before and the procedure must make sure that there is only one occurring signal at the time.

A common phenomenon to see when subjecting both humans and animals to discrimination procedures are persistent systematic position responses. This phenomenon occurs in the simultaneous procedure where the subject is shown more than two samples at the time and the and start to respond to a specific position of the stimulus rather than the stimulus itself, continuing to do so for a series of responses. It is most common in the beginning of the procedure but can also occur later. Position response continues until this difference is changed, equalized or eliminated through reinforcement or non-reinforcement (According to spencer & Langfeld, 1936).

A possible explanation for the position response might be that the response to a specific position has been accidentally put on an intermittent reinforcement schedule. Manual set up of sample sequence might unintentionally place the correct sample in the position that the animal is persistently responding to. This means that it will now and then get reinforced for responding to position making it more likely that the response will be placed on an intermittent reinforcement schedule (Cooper et al, 2007)

Discrimination learning is affected by two basic procedures, reinforcement and extinction. The correct response to the S^D is reinforced, while incorrect responses to the S^Δ are extinguished. When subjecting an organism to a discrimination procedure the extinction in the presence of the S^Δ may often lead to stereotypic behavior, aggressive behavior or self-stimulating behavior that occurs whenever the $S^\Delta$is presented. An example is excessive pecking and wing flapling in pigeons exposed to an extinction procedure (Skinner 1938). The highest rate occurs during the transition from intervention phase of experiments or training and will often fade. Extinction burst are more common during the successive procedure than simultaneous because simultaneous procedure gives the opportunity to earn reinforcers in every presentation, while during successive only responses to the S^D will be rewarded (Skinner, 1938). Sometimes spontaneous recovery occurs, meaning that responses undergoing extinction might reappear with higher intercity. It the extinction procedure remains in effect it will however be limited (Cooper et al, 2007).

In both experimental and applied settings, the consequence of extinction bursts, might be aggression, self-stimulation, frustration or even self-injury. Extinction may set in when the intervals between presentations of an S^D might become too long, thus causing a display of stereotypic behavior, stress related behavior or aggression when it is used during training. In an experimental setting, like an operant chamber, the animal has limited opportunities for responses that can affect anyone else but the animal itself such as self-stimulation or self-injuring (Skinner, 1938). In an applied setting however, the animal might show behavior that is not only harmful to itself but also to experimenters. For instance, it might start showing aggressive behavior towards experimenters which can under many circumstances be very dangerous. The animal might also just walk away, not wanting to participate at all. This can affect or damage the training and the collection of data for an experiment. Terrace (1965) as referenced in Terrace (1974) found that pigeons showed “emotional” responses in the presence of the S^Δ such as excessive packing at the keys and wing flapping which is consistent with what has been seen in applied settings with animals.

Discrimination and generalization

When researching discrimination learning and subjecting a human or an animal to a discrimination procedure researches often look at and test for generalization effect of the stimuli and procedure. Generalization is known as the tendency of responding to stimuli with a similar physical dimension as an already trained stimulus. Or the transfer of a response from a conditioned stimulus to a novel stimulus. The already trained stimulus becomes a controlling stimulus and it occurs as a response to a new stimulus, after a response has already been conditioned to another similar stimulus (Cooper et al, 2007). In applied settings it is desirable that the procedure, or stimuli can be generalized to other settings or other novel stimuli. For instance, when training dogs to discriminate scents it is desirable that the sent discrimination can be generalized to other settings than the training environment if the dog is going to be actively used as a scent dog (Schoon, 2014). In experimental setting it can be investigated if animals can learn to discriminate new novel samples based on already established, such as between painting from different artist such as Monet or Picasso (Watanabe et al, 1995; Watanabee, 2001). This can be researched through the investigation of stimulus equivalence (Steingrímsdóttir & Arntzen). Stimulus equivalence however, will not be discussed in detail in this paper.

Other examples of discrimination procedures in applied and experimental setting

Discrimination procedures are used in a variety of settings with human subjects, such as schools and universities, with disabled people and in research setting. MST procedures seem to be most common can be used to investigate mental disorders, cognition stimulus equivalence or learning (Steingrímsdóttir & Arntzen, 2011), or it can be used to teach a variety of academic skills (Arntzen, et al, 2011). Schools often use discrimination procedures in their education and they are used to teach disabled people different skills they might lack or need improved.

MTS can be used to establish academic skills, such as geographical skills or clock skills and to establish response’s according to stimulus equivalence. MTS procedure can be very effective in establishing conditioned discrimination, and the procedure helps create new untrained stimulus relations that correlates with stimulus equivalence (Arntzen et al, 2011). A variant of

MTS, DMTS, can be used for identifying individuals with early onset of dementia and to be able to differentiate between the different types. It is also used to study affecting variables affects short term memory. Steingrímsdóttir & Arntzen (2011) argues that using a DMTS is a good way to map the progression of dementia, procedure can help train and maintain current mental functions in patients.

Just like with humans, discrimination procedures are widely used with animals, both in experimental setting and in applied setting. Different types of procedures are being used experimentally to investigate a variety of subjects like sensory capacities, the process of learning, cognitive functions etc. In applied settings or in animal husbandry they are also widely used for many different purposes such as teaching training cues or how to respond to different settings and S^D, or they are being used to teach the animals to communicate on, or with, a higher level of understanding (Catania, 2013).

Discrimination procedures are often used when investigation of the sensory capacities in different species, both human and non-human. Both visual, tactile and olfactory senses are being explored using simultaneous or successive discrimination. One study by Dyer and Neumeyer (2005) investigated discrimination capabilities in honeybees by looking at the differences in how well the bees discriminated different colors, blue and yellow, when subjected to the two procedures (Dyer & Neumeyer, 2005)

Other examples of discrimination training in more applied settings are “nose work” with dog and rats. Dogs have excellent olfactory system and can learn to discriminate sent particles many times better than humans. Dogs are widely used to detect different drugs or explosives and also earth corrosion. Schoon et al, (2014) trained dogs to detect corrosion using sent samples collected from corroded pipes. The dogs were trained simultaneously, with 12 samples, to respond to samples containing corrosion. The dogs were rewarded for marking on the correct samples or removed from the room when responding to an incorrect sample or not responding.

The University of Tromsø recently did a study on rug preferences with horses. Mejdell, Jørgensen & Bøe (2016) used discrimination training to teach the horses to communicate blanket preferences. They were taught to discriminate between visual cues indicating if they wanted blanket either off, on or if they wanted no change. The symbols were trained successively until they were established as an S^D before switching to simultaneous training, creating the free choice setting. At first, the horses were taught to associate symbols independently before presenting the two symbols at the time. The no change symbol was introduced after the experimenters were sure that the they could discriminate between the two other symbols, which was tested using a heat test and a cold test. During these tests the horse would be wearing a thick blanket or no blanket making it either to hot or too cold, before presenting the symbols. In the free choice setting the animals could choose simultaneously between the three symbols to indicate their preference. Their results show that all horses learned the discrimination within14 days of training. The result show that 22 out of 22 indicated they wanted blanket of during nice warm days and 20 out of 22 indicated they wanted blanket on during cold days (Mejdell et al., 2016)

Another example of an experiment with both simultaneous and successive discrimination procedures was done by Bogale & Sugita (2014), who investigated shape discrimination and concept formation in jungle crow. The crows were first subjected to a simultaneous procedure to teach them to discriminate between triangular and non-triangular shapes based on compound, color and contour. When they successfully discriminated the red isosceles triangle by reaching an 80% discrimination criterion the procedure was switched to successive and they were subjected to a concept formation test to investigate stimuli transfer of the cues being used and the concept formation ability. During the concept formation test novel triangular and non-triangular shapes was used, the shape size was changed and color was switched. They were also shown samples with conflicting cues. The results of the study show that jungle crows are fully able to not only discriminate between the triangular and non-triangular shapes, but that they also have the ability to discriminate novel shapes. This indicates that shape cues are important for the crow's discrimination decision and that they can form concepts, such as triangularity (Bogale & Sugita, 2014).

Summary

What research and reviews on discrimination learning has told us far is that even though the procedures for investigating it are clearly defined, the term discrimination itself has so far proven to be too complex to be universally defined. There are several theories trying to explain it, such as trial and error learning, or the hypothesis learning (Spencer & Langfeld ,1936). The Hull-Spencer reinforcement theory (as referred to by Loess et al, 1952) and the theory of exposure to reinforcement opportunities (Loess et al, 1952). None of these has so far fully been able to define and explain the term. The procedures used on the other hand are clearly defined and used in both experimental and applied setting to investigate discriminative learning and other learning abilities, sensory capacities, cognitive function etc (Skinner, 1936).

The two main types of discrimination, also referred to as the two main procedures, are simultaneous and successive discrimination. The main difference between these is how the sample stimuli are presented, either at the same time or one at the time. Simultaneous procedure gives a reinforcement opportunity with every trail while successive allows for reinforcement only when the correct S^D is presented. These procedures operate with reinforcement and extinction only (Catania, 2013) Results from several experiments suggests that simultaneous procedure is preferred when investigating discrimination, cognitive functions, stimulus equivalence etc because it is easier than successive as long as the response is required directly on the stimulus source. However, when the response is required to a locus removed from the stimulus source the successive procedure becomes easier. The reason for this has to be further investigated but research suggests it has to do with what type of response is required and the how great the similarity of the stimulus is (Lipsitt, 1961). In addition to simultaneous and successive procedure there are other procedures available, such as MST, DMST (Steingrímsdóttir & Arntzen, 2011; Arntzen, 2011), errorless learning (Terrace, 1963), discrimination with correction or prompts (Armus et al,2006; Cooper et al, 2007) all of which can be used in both applied and experimental settings.

Discrimination learning and discrimination procedures are affected by a number of variables that needs to be taken into consideration. Previous learning history (Skinner, 1938), environmental disturbances (Gabor, & Gerken, 2010), overshadowing and blocking (Catania, (2013), attention (Reynolds, 1961), The Clever Hanse Syndrome (Heinzen, et al. 2015), extinction and spontaneous recovery (Skinner, 1938; Cooper, 2007), position responses (Spencer & Langfeld, 1936) are all variables that might affect the discrimination learning. They might increase, delay or stop the learning acquisition or it might give a false positive result. Previous leaning history might affect the speed of acquisition if the subject has any prior history with the training method. Novice subjects use more time than already trained subjects. Environmental disturbances and position response might delay or stop discrimination learning, while attention, overshadowing, blocking or The Clever Hans syndrome might give a false positive result for discriminative learning.

Available research concludes that all organisms can learn to discriminate between stimuli, they can form concepts and generalize response to other novels stimulus, settings or procedures (Skinner, 1938). Although the procedures for discrimination well defined and described, discrimination learning as an ability have not yet been explained. The subject of discrimination and discriminative learning are probably too complex to be described and explained by one theory alone and more research is needed to come to any conclusions as to how the phenomena works and operates within the organism. Further research is needed to gain more insight and understanding on the subject as well as its generalizing effect.

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A Comparison of Simultaneous and Successive Discrimination Procedures in Captive Animals

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Abstract

Simultaneous and successive discrimination procedures were tested and compared in an applied setting with animal subjects. Two experiments were conducted with different species looking at differences in rate of discrimination learning, the generalizing effect and any significant differences in behavior occurring during the two procedures. In experiment one, two gibbons and two tigers were subjected to either a simultaneous or a successive discrimination procedure to learn to differentiate between shapes. The results indicate that the rate of discrimination learning is speedier using a simultaneous procedure compared to successive based on single repetitions needed before achieving a perfect response loop. It also shows that simultaneous procedure results in less unwanted behavior compared to successive. In a second experiment, four goats, divided into two group, were trained simultaneously or successively to discriminate between colors or shapes. The results are similar to experiment one, showing that simultaneous procedure requires fewer repetitions before reaching a perfect response loop, and that the successive procedure results in more unwanted behavior. During the second experiment two subjects were subjected to a switch in procedure to investigate generalization effect of the procedure. The subject that switched from successive to simultaneous procedure showed a 100% correct response rate, while the subject that switched from simultaneous to successive went back to baseline level. Based on the results of both experiments is it concluded that a simultaneous procedure gives speedier results in terms of rate in discrimination learning and amount of unwanted behavior, however successive procedure seems to yields a wider generalization.

Keywords: Discrimination procedures, Successive, simultaneous, Animal training

A Comparison of Simultaneous and Successive Discrimination Procedures in Captive Animals

There are many theories on how the process of discrimination operates but none have so far been able to define and describe it in a way that covers every aspect of the term. The trail- and error learning theory, the hypothesis theory (Spencer & Langfeld, 1936) and the theory of exposure to reinforcement opportunities (Loess, Duncan & Melton, 1952) are just some of these. In applied behavior analysis discrimination is defined as the ability to differentiate between stimulus, S^D and S^Δ in different sitΔuations or settings. Others have described it before, such as with B. F. Skinner´s laboratory experiments with rats and pigeons in operant chambers where he taught animals to discriminate between colored lights. Skinner (1938) referred to this process as discrimination learning and defined it as the learning of differentiating responses based on specific aspects of a stimulus or learning to respond to a specific stimulus and not similar ones through a combination of reinforcement and extinction operating together. The discrimination happens when the organism learns through differential reinforcement and extinction which stimuli that signals a reinforcer in a specific setting or environment. In other words, it is the ability distinguish between a conditioned stimulus and other similar stimuli that doesn't signal an unconditioned stimulus (Skinner, 1938).

Discrimination procedures are widely used for many purposes in experimental settings as well as applied settings. In an experimental setting these procedures are used to investigate a variety of other areas, for instance cognitive functions, short or long-term memory, acquisition of learning, sensory capacities and thresholds etc. In applied setting they are used to teach different skills such as communication, discriminate between settings, or detection of specific stimuli relevant to humans, such as explosives or drugs (Schoon, Fjellanger, Kjeldsen & Goss, 2014).

It seems that most research done with animals on the subject of discrimination has been in relation to sensory capacities such as olfactory and visual discrimination capabilities, within different species. Examples are visual discrimination in pigeons (Watanabe, Sakamoto, & Wakita, 1995: Watanabe, 2001), jungle crows (Bogale & Sugita, 2014), honeybees (Dyer & Neumeyer, 2005) or olfactory discrimination in dogs (Schoon et al, 2014). These types of experiments use an operant chamber to subject animals to a discrimination problem with lights, color, shapes etc. The discrimination problem can be presented in two ways. Either by presenting all samples that are to be discriminated at the same time, or one by one. These two types of stimulus presentations are known as simultaneous and successive discrimination and they are also known as the two main types of discrimination procedures (Catania, 2013).

Looking at the purely difficulties of simultaneous and successive discrimination most of the relevant research concludes that as long as the procedure is kept simple and that the response is required directly at the stimulus source the simultaneous procedure is easier. But, when the discrimination becomes more complex and demands a response to a locus removed from the stimulus source, the procedures switch and the successive becomes easier than simultaneous. The full explanation for this needs to be investigated further (Bitterman et al, 1955; Lipsitt, 1961: Dyer et al 2005). However, the present experiment will only be looking at a simple discrimination which requires responses directly at the stimulus source.

Simultaneous and successive discrimination procedure operates on alternating between reinforcement and extinction. The desired stimulus is reinforced while all other are extinguished. This means that a simultaneous discrimination procedure offers an opportunity for reinforcement in every stimulus presentation while a successive procedure only offers that opportunity when the desired stimulus is presented (Skinner, 1938). This means that the successive procedure is more prone to higher rate of extinction burst and occurrences of unwanted behavior, often referred to as emotional responses, as a result of that. These can be in the form of passivity, frustration or aggression (Terrace,1963)

An interesting phenomenon that might occur in a simultaneous procedure is the persistent systematic position response. It has been documented in discrimination procedures with many animal, for example horses during Matching-to-sample discrimination (Gabor & Gerken, 2010) or symbol discrimination for communication purposes (Mejdell, Buvik, Jørgensen& Bøe, 2016). Persistent systematic position response, or side preference, means that the subject continues to respond to a specific position rather than the stimulus presented. There are a couple plausible explanations. One deems that is has to do with the excitatory tendencies of that specific position and that it might have a reinforcement history for choosing it (Spencer & Langfeld, 1936), or that it has do with which side the animal is used to being handled from (Gabor & Gerken, 2010). Another theory is that the position response might be caused by intermittent reinforcement of responding to that position if the stimulus sequence is not being shifted properly (Cooper, Heron, & Heward, 2007).

A possible challenge when investigating discrimination learning or using discrimination procedures on animals in a test situation where humans are present is what is known as the Clever Hans effect. This effect was named after the horse, Hans, who became famous for solving puzzles, when he in fact was only responding to small cues from his trainer and the audience (Heinzen, Lilienfeld & Nolan, 2015). Especially when working on a simultaneous procedure, the animal might read body cues and respond to these instead of the discrimination sample, thus giving a false positive for acquired discrimination learning (Mejdell et al, 2016)

Besides the Clever Hans effect (Heinzen et al, 2015), the learning history, overshadowing and blocking (Catania 2013) training environment (Garbor & Gerken, 2010) and attention (Reynolds, 1961), also plays a role when subjecting an animal to a discrimination procedure. Knowing the animals previous learning history is relevant because the animal might have previous history with training and the related stimulus but also because it might give a false positive for acquired discrimination learning (Skinner,1950). Previous learning history with certain stimuli might cause blocking of novel stimuli because they might compete with already established ones. Overshadowing might also happen when two signals are presented at the same time making it uncleared which one is truly effective.

When it comes to the training environment an applied setting allows for less control of unknown variables than an experimental setting and might affect the experiment in unknown ways. For instance, Garbor and Gerken, (2010) found that discrimination training with horses in applied settings was affected by a number of external factors which they had no control over, such as people walking by, tractors, dogs and even the distance between the subject horse and the other horses. Attention also plays a role because sometimes the animal is responding to specific aspects of the environment that are concurrent with the stimuli leading to reinforcement which means that the animal is responding to another stimulus than intended. For instance, Reynold (1961) found that pigeons attended to two different stimuli. Even though both pigeons had been reinforced in the presence of a triangle superimposed on a red key. One individual attended to the red key while the other to the triangle.

When it comes to procedures, in addition to simultaneous and successive discrimination procedure there are other alternatives, which will be briefly discussed later, that might be good options for dealing with some of the variables and behavior consequences, just mentioned, that might occur during a pure simultaneous or successive discrimination procedure. Some of these procedures are errorless learning (Terrace,1963), Matching-to-sample and Delayed-matching-to sample (Steingrímsdóttir & Arntzen, 2011) discrimination procedure with response prompts (Cooper et al, 2007) or discrimination with correction (Dyer, & Neumeyer, 2005: Armus, Montgomery & Gurney, 2006). All of these procedures are widely used with both animals and humans to investigate or teach discrimination (Skinner, 1938).

Through the years a lot of research has been done on visual discrimination of colors and shapes. Examples are Watanabe et al (1995) and Watanabe (2001). Both studies investigated picture discrimination in pigeons using an operant chamber. Watanabe (2001) also added a group of human subjects for comparison between humans and pigeons. The subject was subjected to a simultaneous discrimination procedure to learn discrimination between paintings from different artists and to look at the generalization effect. It was concluded in both the experiments that pigeons can discriminate pictures just as well as humans and that they can also generalize to novel stimuli. A similar experiment has also been done with jungle crows looking at shape discrimination and concept formation (Bogale & Sugita, 2014),

The generalization effect in discrimination procedures is something that needs to be investigated further. Not many, if any studies discuss this term other than as a part or as an effect of the procedure. Most studies talk about it and test for it but doesn't explain the process in detail. Generalization is described as the tendency to respond to stimuli with a similar physical dimension as an already trained stimulus. It is the transfer of a response to from a conditioned stimulus to a novel, untrained stimulus (Cooper et al 2007). Watanabe et al (1995) and Watanabe (2001) trained pigeons to discriminate paintings from different artists and subjected the birds to a generalization test to test for transfer of response to new novel stimulus samples. The generalization effect can be investigated through looking at stimulus equivalence (Steingrímsdóttir & Arntzen, 2011).

Bearing in mind all the previous research on comparison of discrimination procedures, this study aims to measure the effects of using two different discrimination procedures when training animals in an applied setting. The goal of the study was to look at the basics of simultaneous and successive discrimination procedure and it´s effect in an applied setting, measuring any significant difference in behavior displayed between the two and if possible look at the generalization effect between the two procedures. The main experimental hypothesis was that a simultaneous a procedure would result in speedier discrimination learning. A second experimental hypothesis was that the successive would yield more unwanted behavior. The first experiment, functioned as a pilot for the second one. It was done in cooperation with Kristiansand Zoo, Norway, with their tigers and gibbons. The second experiment was done in cooperation with Sötåsen Naturbruksgymnaseum in Töreboda, Sweden, with four of their goats. Both experiments were done in an applied setting with animals that had previous history of positive reinforcement training.

Experiment 1

The purpose of experiment 1 was compare two discrimination procedures, simultaneous and successive, to find out if there were any significant difference in acquisition and behavior, when training discrimination of objects. The training was done with animals in an applied setting at Kristiansand zoo in Norway. The goal of the experiment was to find out if there would be any visible difference in how fast the animal learns to discriminate using the two methods and if there were any differences in behavior or occurrences of unwanted behavior. The main focus was on the discrimination learning rate between three objects based on how many single responses, or repetitions, was needed before achieving a perfect response loop and if there were any differences in behavior as a result of the procedure.

Method

Subjects.

The subjects of the experiment were two gibbons and two tigers, one male and one female of both species. The gibbons were female, Sofie, and male, Erik. The two tigers were female, Tundra, and male, Amur. All animals had previous history of being trained by zookeepers and staff, and they had experience with both clicker training and positive reinforcement training in their daily routines.

Apparatus and setting.

Used in the experiment was a clicker for indicating correct response, three different colored target sticks, three different colored and shaped sand molds, and a holding device for placing the molds. A camera, a computer with excel used to record and register data. A random number generator was used to randomize the stimulus presentation.

The experiment was done in cooperation with Kristianstad zoo, Norway, over a period of approximately five weeks. The animals were trained between three and five days per week and twice each day. Two short sessions, once in the morning and once in the early afternoon. All training was done in protected contact from outside their night time enclosure. The gibbons were trained in their normal indoor enclosure or in their night cages in protected contact.

Procedure.

D*uration and repetitions.* One training session with the gibbons lasted between thirty minutes and forty-five minutes, with one to three minutes breaks. One session with the tigers lasted between fifteen minutes and half an hour, with one to three minutes breaks. Each trial in both successive and simultaneous procedure consisted of ten repetitions before a two to three minutes break. The tigers had shorter sessions and less presentations of stimulus than the gibbons. This was due to the amount of food available for training.

Training structure and stimuli. The experiment compared two different procedures for training discrimination of objects to animals. One successive and one simultaneous procedure. One animal of both species was subjected to one of the two procedures. The procedure was the same for both species, with the exception of what kind of stimulus was used, what reinforcers was used and what behavior was registered as correct marking behavior, or target behavior. Because the two species have different diets, fruit and vegetables was given as reinforcement for the gibbons, and pieces of meat for the tigers. The correct target behavior, touch, was defined slightly differently between the two species. With the gibbons the target behavior, touch, was defined as touching the object with a hand for more than three seconds. For the tigers, the target behavior was defined as pressing the nose onto the bars of their enclosure closest to the correct object and holding it there for more than three seconds. During baseline, all touches was registered as correct target behavior and rewarded. In the intervention phase during the simultaneous procedure the touch was only registered as correct target behavior when the right target stick or sand molds, defined as the S^D, was present. All others were defined as S^Δ and were not reinforced. However, during the successive procedure there was two defined target behaviors depending on the presence of S^D or S^Δ. When the S^D was present the target behavior was “touch” as defined above. When the S^Δ was present, the correct target behavior would be withstanding from touching, no touch, meaning that the animal could do anything other than touching it. The “no touch was not reinforced. In both procedures it was also registered if there were any occurrences of unwanted behavior during each trail. This was recorded per trail of ten presentations and if it happened in relation to the S^D or S^{Δ}. Unwanted behavior could be signs of aggression, emotional responses or signs of stress, such as pacing back and forth or other behavior, such as leaving. The intervention was considered successful when the subject responded with eighteen out of twenty correct responses in a row. When his criteria were met it was considered that the subject had successfully learned the discrimination.

In both procedures, each session was initiated by separating the animals. Then the experimenter would get the animals attention by asking it to perform a recall behavior and stationing. The animal would come when called and lie down or sit down on a specific place, ideal for training. Reinforcement was delivered for both recall and stationing. When the animal was on station and showing interest by participation, the session would start. If a pause was needed it was indicated to the animal by giving one larger piece of reinforcer, raising one hand and saying “pause”, before walking away. Each session was also ended by giving one larger piece of reinforcer, slowly waving two hands in front of the animal and saying “finished”, before walking away.

In the simultaneous procedure, a holding device with the numbers one to three written on it, and three sand molds in different shapes and colors was presented in front of the animal. The molds were placed approximately 25 centimeters apart from each other and was presented in sequences of ten repetitions, before a two-to three-minute break during both baseline and intervention. The molds were randomly placed and switched around after each presentation. The placement and sequence of the molds was created with a random number generator. The criteria for correct target behavior was that the animal touched one of the sand molds within five seconds, and that the animal kept the touch for at least three seconds. During baseline, it was recorded if the animal touched the sand molds, which mold it was and where that mold was placed. Each touch resulted in reinforcement. During the intervention, the animal would only be reinforced for touching one specific mold, now defined as the S^D, with each presentation. Touching one of the two now defined as S^Δ other would lead to withdrawal of the molds and no reinforcement, before a new presentation. Each presentation of the molds had the possibility of delivering reinforcement.

In the successive procedure, one of three target sticks would be presented close enough to the animal so that it could either touch with a hand or nose, approximately 2 meters in diameters around the animal. The touch would have to happen within five seconds to be registered as correct target behavior. Just like the simultaneous procedure the S^D and S^Δ was presented in sequences of ten before a two-to three-minute break during both baseline and intervention. The sequence the targets was presented was randomized during both baseline and intervention. This was done with a random number generator. When the animal touched the target for more than three seconds it would be removed and reinforced before a new one would be presented. During baseline, it was recorded if the animal touched it or not, regardless of size and color, and which one was presented. During intervention only one target would be defined as the S^D leading to reinforcement. The two others would function as S^Δ and not be reinforced. It was recorded which target was used if the animal touched it or not and the sequence the targets was presented. As described above correct target behavior registered was defined as "touch" when the S^D was presented and "no touch" when S^Δ was presented.

Results

The result of the experiment, as shown in *Figure 1* and *Figure 5*, shows that all of the four animal subjects successfully learned the discrimination task. As shown in *Table 1*, the highest number of total sample presentations, before reaching a perfect correct response loop of eighteen out of twenty correct responses, was 810 samples presented during successive procedure with the female gibbon, and the lowest was 290 samples during the simultaneous procedure with the female tiger. In both species the two individuals subjected to the simultaneous procedure learned the shape discrimination faster than those subjected to the successive procedure with an average of 375 responses compared to 600. *Figure 1 and Figure 5* show that for both species the simultaneous procedure required fewer sample presentations than the successive. The female tiger subjected to simultaneous discrimination achieved a perfect response loop after 290 sample presentations during intervening, while the male subjected to successive procedure required a total of 390. With the gibbons, the male, subjected to simultaneous procedure, achieved a perfect response loop after 460 sample presentations during intervention, while the female subjected to successive procedure required 810. As shown in *Figure 1* and *Table 1*, the tiger subjected to successive procedure required a total of 100 more sample presentations compared to the tiger subjected to simultaneous procedure. *Figure 2* and *Table 1*, shows similar results with the gibbons. The female gibbon, subjected to the successive procedure, required a total of 350 more sample presentations than the gibbon subjected to simultaneous. However, the successive procedure with the female gibbon had a much higher total sample presentation with 810 compared to the tiger with 390. The reason for this is unknown and will be taken up for discussion.

Based on results shown in *Table 2* and *Table 3*, it can be seen that there is a difference in unwanted behavior after initiating the intervention. It also shows that there was a difference between the two procedures. During baseline, in both procedure combined, there were six trials containing unwanted behavior. One case of aggression and stress related behavior and three cases of the subject leaving for unknown reason. During the intervention however, the total amount of trials containing unwanted behavior is higher during the successive procedure the simultaneous. During successive procedure there was a total of 37 trail containing unwanted behavior. Twenty-three of these were trails containing stress related behavior, seven contained aggression and seven were the subject left. During the simultaneous procedure there was a total of eleven trails containing unwanted behavior, nine were aggression by the female tiger and two where the subjects left. The successive procedure has an average of 21 trials containing unwanted behavior compared to simultaneous with an average of 6 trials. Based on this it is concluded that the successive procedure produces much more unwanted behavior than the simultaneous. What is also interesting to note, as *Table 3* illustrates, is that all of the unwanted behavior occurred either when the subject was presented a S^{Δ} during successive procedure, or after responding to a S^{Δ} during simultaneous procedure.

Both animals in the simultaneous group showed signs of persistent position responses, or position habit. *Figure 3* and *Figure 4* showed the total position habit responses made by the tiger and gibbon subjected to the simultaneous procedure per trail of ten samples. As shown in the *Figures 3* and *Figure 4*, as well as *Table 4* both animals showed signs of position responses during baseline. During baseline the tiger, Tundra, showed a preference for position three, with 74 responses of 150 possible, while the gibbon Erik, preferred position two with 78 out of 150 responses to that position. The distribution of responses to the positions equals out over time as shown in *Figure 3* and *Figure 4.* Erik continued to have a higher response rate to position number two before it equals because it shifts to sample responses out after trail number 50, while Tundra started to respond more to the samples at approximately trail number 24, almost half the number of trails.

When it comes to generalization of the procedure there is unfortunately not enough evidence to make any conclusion about the generalization effect because the experimenter did not have enough time to be able to switch procedures.

Discussion

The results of this experiment on discrimination procedures corresponds with previous research results on the subject, indicating that simultaneous procedure is yields faster learning compared to successive (Bitterman et al, 1955; Lipsitt, 1961: Dyer et al 2005; Loess et al 1952). It also showed a higher amount of unwanted behavior during the successive procedure than the simultaneous procedure which consistent with findings from discrimination training with pigeons (Skinner, 1938).

One of the limitations of this experiment was the fact that there was a small sample size, with only two groups of two individuals each. Ideally it would have been better to have a bigger sample size for comparison which also might have given more conclusive results. Due to the setting in which the experiment was done, this was not possible to accomplish at that time. A bigger sample size would have given a much clearer result and possibly grounds for making a more reliable conclusion about the effectiveness of the two procedures.

The discrimination problem used was a three-choice simple discrimination working purely with reinforcement and extinction, and with a response required directly at the stimulus source (Lipsitt, 1961). The stimulus used was easy to differentiate because it was different in both size and color making it more likely that the subject would recognize the difference. It has been shown that the more similarity there are between the stimulus, the harder they become to discriminate which might equalize the procedures or make the successive procedure speedier (Bitterman et al, 1955). All of this taken into consideration makes more likely that the hypothesis would be correct in terms of simplicity in the procedure and between the stimuli used even in applied settings.

This experiment was done in an applied setting and not in an operant chamber. Similar experiment has been done in these chambers to look at for instance sensory capacities or learning acquisition, often with pigeons and rats. This setting allows for a more controlled and sterile environment that is not as affected by the same amount of environmental disturbances as an applied setting would be (Skinner, 1938). One of the challenges of working in an applied setting and training environment is the fact that there are much more distractions and affecting variables that can be both unknown and hard or impossible to control (Garbor & Gerken, 2010) With both the tigers and the gibbons used in this experiment both environmental disturbances and separation needed to be considered and accounted for when training since it could possibly affect the experiment. In this setting the animals needed to be separated, potentially creating stress responses, during the procedure and the fact that they were always in contact with a lot of environmental disturbance during the procedure the experimental training needed to be as equal as possible all the time. Because of that it was done at the same time of day and the same procedure for separation was always used. Based on the results it is highly likely that these variables were not an affecting variable for the two tigers and for the male gibbon.

Another variable that might be effective and can cause limitations is the subjects previous leaning history. The experimenter had little knowledge of how much training experience the animals had but knew that all had previous experience with training a variety of different skills using positive reinforcement training. It was known that both individuals for both species had approximately the same amount of training, which meant that both individuals were at the same level when training. The measures taken to prevent this having too much effect was making sure that the experimental training sessions were done with new novel samples and in a way that did not resemble any of the day to day training. How much this effected the experiment is unclear.

However, the results with the female gibbon shows that she used almost twice as long compared to the tiger to learn the successive discrimination and showed a higher amount of stress responses, in the form of excessive handshaking, than any of the tree other animals. What this indicates is that environmental disturbances and/or separation might be an affecting variable. This indicates that no matter how similar or familiar the procedure is in an applied setting, there will always the risk of unknown variables that can cause stress responses or other behaviors. Garbor and Gerken (2010) experienced similar results when working on Matching-To-Sample procedures in horses. They found that the horses would show startling responses and react to uncontrolled environmental cues and separation, affecting parts of the training. These are some of the challenges when working with animal subjects in applied settings when separation might be necessary and there are too much environmental disturbances. Training for a safe and stress- free environment with a stress-free separation method might be good options when working in applied setting.

In this kind of experiment working with animal subject in an applied setting, body cues are something that might be of importance when recording data. This can be seen in the form of the Clever Hans syndrome. The horse named Hans was known for his ability to solve puzzles, math questions and other problems. People came from all over believing in his special abilities. However, it was discovered that he was in fact reacting to body cues, or peoples body language. Animals often look at body language when interacting with us and they often react more to that than to other stimuli. For instance, it might be the way we turn or body, or if we look at something in a specific way, or if we move a certain way, that might give the animal cues to react to. An animal might learn a behavior based on our body cues and not the experimental procedure. This might be something to consider, especially with the gibbons who are extremely social and easily very interested and susceptible to human body language. They will easily pick up on our body language and react to that more than they might react to the stimuli presented to them in an experiment (Heinzen et al, 2015). This is one of the advantages of have a fully automated system when working on discrimination problems because that will eliminate our body language as a third variable. Since this was not an option during the experiment it was required that the experimenter controlled her body language as best she could, trying not to look at the samples, do any hand movements or shift in weight etc that might indicate to the animal the correct response.

A common phenomenon seen when subjecting both humans and animals to discrimination procedures are side preferences also known as persistent systematic position responses or response position habits. Why this occurs is still somewhat unclear but some indication is given to the fact it might be connected to the reinforcement schedule or the excitatory tendency of a particular position. It is more common in unsophisticated learners and occurs early in the training and will continue until extinguished (Spencer & Langfeld, 1936). Some theories, concerning livestock and farm animals, also considers that it has to do with which side the subject animal is used to being handled, and that this affects which side the animal chooses (Gabor & Gerken, 2010). During this experiment the theory about which side the animal is being handled is not really relevant since neither the tigers or the gibbons are being handled in any way relatable to livestock. However, the theory related to reinforcement schedule might be a plausible explanation. Even though the procedure used a random number generator to create the sample sequence it did not take into consideration the position habit and did not have any good way of countering it. This means that the generator might have placed the correct S^D intermittently on the position the animal was consistently responding to, putting the response to that position on an intermittent reinforcement schedule. An intermittent reinforcement schedule for position response might hinder the extinction of the S^{Δ} (Skinner, 1938). This might help explain why Erik continued having a higher response rate to position number two up until trial number 50 which is twice as long as Tundra with 24 trails.

Another relevant factor to consider is unwanted behavior, which is basically any behavior the experimenter do not want to occur, which can have multiple plausible explanations. The most common explanations seem to be related to the setting or environment, or it can be a result of procedure-based extinction burst. The successive procedure operates with a higher level of extinction than the simultaneous procedure than the simultaneous. Subjecting an organism to an extinction procedure often create extinction burst consisting of attempted solution to the problem (Cooper, 2011: Skinner, 1938). Unwanted behavior and extinction bursts will be further discussed later in the general discussion.

Because of the time limit it wasn't possible to do a reversal of procedure. This means that based on these results the experiment gave it can't make any conclusions about the generalization effect of the procedures. No sources have been found that can give any indication as to which procedure might give the best generalization effect. But based on the fact that successive procedure teaches a no-go response whenever presenting the S^{Δ}, it might be plausible to think that the successive procedure would give a better generalization effect (Skinner, 1938).

Experiment 2

Experiment 2 is a replication of the first experiment, as described and explained above, on discrimination procedures in applied animal training. The experiment was done at Sötåsen naturbruksgymnaseun, Tøreboda Sweden. Just as in experiment 1, the aim was to look at how fast animals learn to discriminate between objects using simultaneous and successive discrimination in applied settings. It compared how many single S^D presentations was needed before achieving a perfect loop of at least eighteen correct responses out of twenty. Experiment 2 was designed based on the procedure and experiences made during experiment 1, but with some small modifications and variations. In this second experiment, the focus was on look what behavioral differences would occur when training animals to discriminate between object using, simultaneous and successive discrimination procedures. This means that it firstly looked at what differences would occur in how fast the animal learns to discriminate between objects, in terms of single repetitions needed, but it also looked at what behavioral consequences would occurunder the two procedures, such as unwanted behavior in the form of aggression or frustration. It also looked at generalization effect when switching between the two procedures.

Method

Subjects.

The study used two species of animals. Four goats. There were three female goats and one male goat. All four goats had previous history of positive reinforcement training, fear free handling and some clicker training.

Apparatus and setting.

Apparatus used in for the experiment was a clicker, for indicating correct response, six different target sticks, six sheets of laminated paper, three with different colors and three with different shapes, and four holding devices for presenting them. The target sticks and sheets of paper functioned as the stimulus the animals was learning to discriminate between. A video camera, a Gopro camera and a computer was used to record and register some of the data. A random number generator was used for randomizing the sequence of the stimulus presented. The experiment was done in cooperation of Sötåsen naturbruksgymnaseum, Sweden, over a period of five weeks. All animals were trained twice a day. Once in the morning and once in the afternoon. All training was done in protected contact.

Procedure.

Duration and repetitions. One training session lasted between ten and fifteen minutes per animal, depending on which procedure was trained. During simultaneous procedure one trial consisted of four stimulus presentations before a 30 second to one-minute break. Breaks was used for data recording and rearranging the S^D and S^Δ. During successive procedure one trial consisted of six stimulus presentations before a 30 second to one-minute break. Breaks were used to register data. The animals subjected to the simultaneous procedure had on average shorter sessions and fewer stimulus presentations in total than those subjected to successive procedure. This was due to the difference in how many presentations was done and the preparations needed between trials. For comparison reasons the results were calculated in sets of ten.

Training structure and stimuli. This experiment compared two different procedures for training discrimination of different stimulus with animals, successive and simultaneous. Two goats were subjected to simultaneous procedure, and two to the successive procedure. The stimulus used was laminated sheets of paper, either with colors or symbols. Colors used were white, black, yellow, blue, green and grey. Symbols used were a blue circle, a yellow star, red square, green triangle, red heart and a blur cross. As reinforcement, the goats were given apple and crispbread. The stimulus presentations were done by attaching the laminated sheets on a holding device and presenting it either in front of the goat or on the side. This was dependent on the goat's proximity to the wall. In the simultaneous procedure, there was one target behavior, touch, while in successive procedure there was two, touch and no-touch. The target behavior "touch" was defined as the animal putting it´s nose on the stimulus and holding it in position for at least three seconds. The touch also had to happen within four seconds to be registered as a touch. The target behavior "No- touch" was defined as the animal showing any other behavior except touching the stimulus. The discrimination would be considered learned when the animal responded with eighteen out of twenty correct responses, allowing only one mistake per ten sample presentations.

During both baseline and intervention, in both procedures, it was registered if any unwanted behaviors occurred per ten samples presented and if it occurred in relation to the S^D or S^Δ. Unwanted behavior was anything related to emotional responses, aggression or stress. Or if the animal left.

Each session had a starting signal, a pause signal and a stop signal. Every session would start by getting the animals attention by saying its name and giving a reinforcer for coming over and participating. If a pause was needed experimenter would say "pause", give a larger piece of reinforcer on the ground before walking away. The same would be done at the end of each training but using the word "eat" instead of "pause". Both procedures were started, paused and finished in the same way with both species.

Before baseline-training could begin, some of the animals had to go through a couple of sessions with pre-training. Pre-training was necessary because some of the animals had little to no experience with target training and needed to learn how to touch the target. The goats also showed some fear responses in the presence of the sheets of papers used as stimuli. Pre-training meant presenting a stimulus, similar to the one used in the experiment, and reinforcing the animal for touching it. One session of pre-training took approximately three to four minutes with between ten and fifteen repetitions, each being reinforced.

In the simultaneous procedure the animal was presented with three sample stimuli, three colored laminated sheets of paper. Criteria for correct target behavior was that the animal touched one of the targets or one colure within four seconds and holding it for at least two seconds. The samples switched places between every presentation and the trial sequence was created using a random number generator. Four presentations were done before a short break. Breaks was used to rearrange the stimuli on the holding devises before the next trial of four presentations. During baseline, every touch was reinforced and it was registered which placement the stimulus had and which one the animal touched. In the intervention two of the three stimuli became S^{Δ} and only one S^{D}. This means that every presentation gave the opportunity to earn reinforcement, but only by touching the right color, symbol or target stick defined as the S^{D} within the time limit. It was also registered if there were any occurrences of unwanted, negative or alternative behavior occurring between or during the presentations.

In the successive procedure the animal was presented with one sample, a color, in a proximity of one to one and a half meters. Six presentations were done before a short break. The sample was switched between every presentation and the sequence was created using a random number generator. During baseline it was registered which order the samples was presented and whether the animal touched it or not. Every touch within the five seconds was reinforced. In the intervention two of the three samples now function as an S^{Δ}. and one was still functioning as a S^{D}. Only touching the S^{D} would lead to reinforcement while touching one of the two samples now defined as S^{Δ}. other would lead to withdrawal of the samples and no reinforcement, before a new presentation. It was recorded which sample was used, if the animal touched it or not, and which sequence they were presented. During this phase there was two correct target behaviors, “touch” and “no-touch”. “Touch” was registered when the animal touched the S^{D} by putting its nose directly on it. The “no-touch” was registered when the animal did anything except putting its nose on the *S*$^{\Delta}$.

The generalization between procedures test was done with two individuals. The procedure training was identical to the previous training with the exception of a switch in animal. One animal that had been trained simultaneously was now trained successively, and one animal that had been trained successively was not trained simultaneously.

Results

The results from this experiment supports the previous experiment done at Kristiansand Zoo. *Figure 5* and *Figure 6* shows that for both pairs of subjects, the individual subjected to the simultaneous procedure used on average fewer repetitions compared to the successive procedure. Including baseline, the pair subjected to the simultaneous procedure used a total of 250 and 410 repetitions before reaching a perfect response loop of eighteen out of twenty correct responses. The pair subjected to the successive procedure used 510 and 530. As shown in *Table 5*, the average amount of responses during intervention was 305 for the successive group and 470 for the simultaneous group. This shows that the successive group on average needed more repetitions than the simultaneous.

As seen in *Table 6* and *Table 7* shows the successive procedure seems to produce more unwanted behavior than the simultaneous. No unwanted behavior occurred during baseline for both procedures. During intervention in successive procedure unwanted behavior was recorded 48 times, based on counts per ten sample presentations, while during simultaneous only 14 times during successive. That gives an average of 7 compared 27,5. This means that the simultaneous procedure is much more likely to cause unwanted behavior. Aggression was only registered in the simultaneous while stress related behavior, leaving and other behavior occurred in both. *Table 7* shows that 89 % of the unwanted behavior occurred in relation to a sample presentation containing an S^{Δ}. while only 11 % occurred in relation to a sample containing an S^{D}.

Like experiment 1 in Kristiansand Zoo, both subjects in the successive group shows signs of persistent systematic position responses. As seen in *Figure 7, Figure 8,* and *Table 8*, both individuals seemed to preferred third position, the symbol on the right side, during baseline. Goat 1, Geisha, responded 40 out of 50 times to position number tree while goat number 3, Leiah, responded with 30 out of 50 to the same position. As shown in *Figure 7*, Geisha favored third, the right, during baseline and switched to one, in the beginning of the experiment. The response equaled out and she started responding more to the sample after 160 sample presentations. As shown in *Figure 8*, Leiah started position habit of responding to position number tree and shifted to two at the beginning of the intervention, before equaling out and starting to respond more to the sample at approximately 230 responses.

As shown in *Figure 9*, when switching procedure from successive to simultaneous or vice versa the successive group seems to give a wider generalization effect than the other. When the individual that was first trained successively was switched to simultaneous training reached the perfect loop with twenty out of twenty correct responses with no errors. The individual trained simultaneously showed considerably more errors with only five correct responses out of twenty and responded to every S^{Δ} presented when switching procedure. Unfortunately, the switch between procedures was only done with two individuals so there is not enough data to make a final conclusion.

Some of the results that will be taken up for discussion is the fact that the subjected in the simultaneous procedure showed unwanted behavior in the form of stress related behavior during samples containing S^{D} and S^{Δ}. It will also be discussed the fact that goat number 3 uses twice the amount to responses for completing the simultaneous discrimination task shown in *Figure 5* and *Figure 6*. Also, interestingly enough goat number 2 and 4, Isabell and Vilgot, who were subjected to the successive procedure showed signs of adjacent behavior when given the food reinforcer. In several occasion drinking water, recorded as "other behaviors" occurred right after or in between stimulus presentations if the animal had access to water.

The results of the experiments support the results from experiment 1. It can be seen that simultaneous discrimination procedure is faster, terms of single repetitions, compared to successive. What is also concluded is that successive procedure yields more unwanted behaviors than simultaneous. Also based on the results in the procedure switch it plausible that successive procedure gives better generalization effect than simultaneous. This needs to be further investigated to make a final conclusion.

Discussion

The results of experiment two indicate that when comparing simultaneous and successive discrimination procedures, the individuals subjected to the simultaneous procedure learns the discrimination faster than the individuals subjected to the successive procedure. This is supported by findings in other studies (Bitterman et al, 1955; Lipsitt, 1961: Dyer et al 2005)

A shortcoming for this experiment was the small sample size. There were two groups of two individuals, which is too small a sample size to make any final conclusions that apples to more than this experiment only. Although it gives a strong indication it might be it is not enough to say anything final. It would have been preferable if possible to have a larger sample size, but in this setting and with the animals at hand that wasn't possible. It would also have been an advantage if more than one pair of animals had been tested in the procedure switch to be able to strengthen the results and maybe be able to draw a conclusion.

This experiment was done in a fully applied setting with animals in their natural environment. For these four animals, separation necessary to be able to do any kind of training involving food rewards. The intended animal was separated from the others in a stall, which they were used to being in but not alone. The animals could not see each other, but they could hear each other. As seen in *Table 6*, all four individuals, in both groups showed stress related behavior such pacing, trying to jump over the fence and excessive vocalization during the intervention phase where rewards are not coming as frequently as in baseline. These are similar as results found other livestock such as horses. Livestock in general are social herd animals, which rely on each other quite a lot. Separation from the herd are common triggers for a variety of stress related behaviors (Mejdell et al, 2016). Unfortunately, because of the setup of the experiment there was not any options for countering, probably, separation induced stress. What could have been done was to set up a training area where the animals could see each other and not only hear. This might help reduce stress responses.

Since previous learning history needs to be taken into consideration since it can be an effecting variable and limitation the experimental training was separated for all other training. (Spencer & Langfeld, 1936) It was known that all four subjects had experience with positive reinforcement training and that all of them were on approximately the same level. During the experiment there was no other active training sessions and the experimental training was set up so that it was different from all other training. All stimuli used was new and novel to the subject and they had no previous history with this kind of training. If previous learning history had any effect on the experiment is unclear but based on the results it is likely that it has not been an effective variable.

Occurrences of unwanted behaviors could also appear as side-effect of the extinction occurring during the successive procedure, especially aggressive behavior seems to be a common reaction when the sample that previously gave reinforcement no longer works. Extinction burst will be further discussed later, in the general discussion (Cooper, 2011: Skinner, 1936).

As mentioned in the discussion of experiment 1, the Clever Hans syndrome is also a relevant factor during this experiment for the same reasons. Cues by trainer given unintentionally always needs to be considered when working hands on with animals in an applied setting. This will also be further discussed later in the general discussion (Heinzen et al, 2015).

As seen when comparing *Figure 5* and *Figure 6*, goat number 3, Leiah used twice as long as goat number 1, Geisha, to complete the simultaneous discrimination. There are several plausible explanations for this, as shown in *Table 6*, Leiah showed more unwanted behavior then Geisha during intervention which also might have affected the responding. It might be that environmental disturbances and the separation are just too much this individual (Garbor & Gerken, 2010), or it might be because she came into heat during training. Much of the stress related behavior was excessive vocalizing, pacing, leaving, climbing onto walls, all of which was approximately between sample presentation 300 and 350.

Another plausible explanation, it she systematic position response or position habit. Both goats, as shown in *Figure 7*, *Figure 8* and *Table 8*, in the simultaneous group showed strong position habits. Interestingly, after initiating intervention both switched the position habit to another position before equalizing responses and shifting to a sample response (Spencer & Langfeld, 1936). The reason for this is unknown but one can speculate that the beginning preference with the right position might be related to how the animals are used to being handled during training. All the goats had previous history of target training, meaning that they often get reinforced for touching a target to in a direction away from the handler. Even though no conclusive evidence has been found regarding this it has been brought up for discussion in relation to livestock by other studies in other studies (Garbor & Gerken, 2010). A third plausible explanation, also mentioned earlier, for this phenomenon might be that position response has accidentally been put on an intermittent reinforcement schedule. Because this experiment was done in a fully applied setting with no automatic system that would take this variable into consideration it might be an affecting variable. Even though a random number generator was used it might have not been able to account for the position response well enough to counter it (Skinner, 1938).

During this this experiment two of the animals was subjected to a switch in procedure after they mastered the discrimination task. The intention was to look at the generalization of the discrimination from one procedure to the other. The results, as shown inn Figure 9, shows that the subject switching from successive to simultaneous did much better compared the subject switching from simultaneous to successive. This means that the discrimination generalized better from the successive to simultaneous procedure compared to simultaneous to successive. Why this is the case needs to be investigated further but it might be related to the fact that the two procedures have two different ways of presenting the samples. During the simultaneous procedure the animal always has to respond meaning that it never learns to not respond in the same way as in the successive procedure. This enables the animal to learn when to respond but also when not to respond (Spencer & Langfeld, 1936: Skinner, 1938). This can be especially useful when working with animals in an applied setting because one goal is often to make sure that the discrimination can be transferred into other setting and situations, for instance with scent dog. They are required to learn to discriminate a specific scent and then generalize this into new settings and situations, often with more and new novel stimuli (Schoon, 2014).

An interesting side note to mention was that the two goats subjected to the successive procedure showed signs of adjacent behavior when given the food reinforcer. Because they were trained in their natural environment, nothing was changed in their stall. This meant that they had access to a water bucket in one of the corners of the stall. As shown in *Table 6*, this behavior was recorded during 25 sets of ten in total, 13, with goat two, Isabell, and 12 with goat four, Vilgot. What was interesting is that the drinking behavior occurred as a response to the S□ whenever they had gotten food reward within a couple of responses. Adjacent behavior is a topic for another discussion however it was worth mentioning.

General Discussion

The results of both experiments indicate that simultaneous discrimination procedure produce speedier learning than simultaneous procedure when training stimulus discrimination in animals. This is also supported by other findings from studies with both humans and animals (Bitterman et al, 1955: (Lipsitt, 1961: Dyer et al 2005). The experimental results indicate that the successive procedure creates more unwanted behavior after initiating the intervention compared to the simultaneous. But based on the switch in procedure it is also indicated that successive procedure gives a better generalization effect than simultaneous.

A disadvantage and shortcoming for both Experiment 1 and Experiment 2 was the small sample sizes in each. Both had only two groups with two subjects in each, which might be too small sample size to be able to make any final conclusions about the results other than for the specific experiment. Even though both experiments show similar results it would have been an advantage having more results to base the conclusion on. It would also have given the opportunity to test the procedure switch on more subjects. Unfortunately, it was not possible during that time or in that setting to get more subjects to train which means that the results are only fully conclusive for these two experiments. However, they do give a very good indication that simultaneous procedure yields speedier learning and wider generalization.

Other research done indicates that as long as the discrimination requires a response directly at the stimulus source and that the distinction between the samples are high enough, the simultaneous procedure is easier than successive. This corresponds with the findings of both of the experiment (Lipsitt,1961). As mentioned earlier, both experiment 1 and 2 are very simple discriminations requiring a response directly at the stimulus source with highly distinguishable stimulus used which supports the claim that simultaneous discrimination is easier. Had the stimulus that was been more similar or required another response removed from the stimulus source the results might have been more equal or reversed (Lipsitt,1961). Some also argue that the difficulty of the procedure has to do with the amount of reinforcement opportunities. During a simultaneous procedure there will always be a chance of reinforcement while during the successive this depends on the sample presentations. This means that during the present experiment there is a 33% chance of reinforcement while during successive procedure the chance of reinforcement is unknown. If this has any affect or not is not visible in the results and are in need of more investigation (Loess, et al,1952)

Previous learning history is relevant in relation to both experiment 1 and experiment 2. In an experiment, depending on the intention, it might be an advantage to have subjects with the same amount of previous learning history. If they are on different levels and have different skillsets the results might be influenced by this one way or the other. It might be that an animal has previous history with the training method or the stimuli used that effects the experiment in a positive or negative way. If the subjects are the same level and have the same skillsets it might give a more correct and plausible result because there won't be any familiar factors that might elicit a response (Spencer & Langfeld, 1936). Both Experiment 1 and Experiment 2 was done with animals that had a previous learning history with positive reinforcement training. Fortunately, all subjects in both experiments had approximately the same amount of training and reinforcement history, and all experimental training were set up in a way that it should not be affected by it. Also, all stimuli used in the experiment were new and novel to the animal. If this was affective variable is unclear but based on the results it seems less likely.

Because of the differences in setup of the environment and the usage of an already established signal for reinforcement, it is not believed that overshadowing or blocking of stimulus was an occurring factor during the two experiments. The signal for reinforcement used was already established in all animals and the procedure was done so that only one signal was occurring at the same time (Catania, 2013) If term attention is relevant in these experiment needs to be investigated further. In this kind of experiment in an applied setting there are a lot environmental aspect that might occur and affect the response. Also, it seems to be comparable to The Clever Hans Syndrom, when human body language, occurring at the same time as the sample might elicit the response. (Reynolds, 1961).

The results from both experiment show a higher amount of unwanted behavior during successive procedure compared to the simultaneous procedure. Unwanted behavior is basically any behavior the experimenter does not want to occur, such as aggression, stress related behavior, leaving or other behavior. Aggression can be towards the apparatus or parts of the enclosure or towards the experimenter. Stress related behaviors can be shaking body parts, pacing back and forth, climbing on the walls or fences, or excessive vocalizing. Leaving means that the animal simple walks away. Other behavior means any behavior that does not fall under the other categories.

Unwanted behavior can have many plausible explanations. It can be procedure induced such as extinction bursts resulting from introducing the S^{Δ} in the intervention or it can be caused by the setting or environment. Most of the all of the unwanted behavior in both procedures occurred in relation to a presentation or a response to the S^{Δ}.Pigeons has been recorded showing excessive pecking whenever exposed to an S^{Δ} during a procedure in an operant chamber, which corresponds with the results shown here (Terrace, 1963). During this experiment there was only one recording of unwanted behavior during baseline, all others were during the first part of the intervention. However, two of the subjects in experiment two showed unwanted behaviors during both S^D and S^{Δ} which indicates that these two individuals responded to environmental disturbances due to setting and separation from the other animals which is consistent with findings in study done with horses and other livestock (Garbor & Gerken, 2010).

With some animals unwanted behaviors such as extreme aggression might endanger both the experimenter and the subject itself. During a pure successive discrimination procedure operating with only reinforcement or extinction this might be hard to counter or stop. It can therefore be a good alternative to look at combining it with elements from other procedures such as mentioned, that might occur during a pure simultaneous or successive discrimination procedure. Some of these procedures are errorless learning (Terrace,1963), discrimination procedure with response prompts (Cooper et al, 2007) or discrimination with correction (Dyer, & Neumeyer, 2005; Armus et al,2006)

The easiest of the alternative elements to combine the procedure with errorless learning, a prompting procedure or correction for wrong responses (Terrace,1963: Cooper et al, 2007: Dyer,

& Neumeyer, 2005: Armus et al,2006). Even though these procedures are well defined and applied, a full comparison is lacking and there is a need for further research on the subject, especially in applied settings with animal subjects. Research has that errorless learning decreases responding to S^{Δ}, which can help hinder unwanted behavior (Terrace, 1963) An alternative form of errorless learning often used in applied setting by zookeepers, would be adding an alternative behavior when presenting the S^{Δ}, and training this parallel to the discrimination so that each sample presentation always gives the opportunity for reinforcement. However, this method does not seem to be scientifically explored or described so we will not discuss this further.

Another alternative would be adding prompts. Prompts can also decrease responses to incorrect sample. It has been shown with children that adding prompts to the procedure can decrease unwanted behavior, although more research is needed in relation to prompting used with animals (Cooper et al, 2007: Catania, 2013). An element that is also considered effective is adding a correction element to the procedure by adding an aversive as a consequence to responses to the S^{Δ}, such as an electric shock (Armus et al, 2006) or the usage of saltwater with honeybees (Dyer, & Neumeyer, 2005). Adding an aversive creates an avoidance response to the S^{Δ} increasing the likelihood that the responses to that sample will decrease. Even tough an aversive might be affective results show that is only affective as long as it is consistent. If the aversive is eliminated the avoidance response will extinguish which might indicate that the response is maintained by the aversive and not the positive reinforcement (Armus et al, 2006).

Systematic position response, response habit, is a common phenomenon when subjecting an individual to a simultaneous discrimination procedure. All the animals in the experiment subjected to the simultaneous show response habit during baseline and well into the intervention before the response shifts to the samples. The reason for these phenomena are still under investigation but its occurrences in the beginning of learning can be explained in terms of differences, either innate or acquired, caused by one of the positions excitatory strengths, this can be tied to previous learning history (Spencer & Langfeld, 1936). Another plausible explanation for this occurring might be that the response to position is unintentionally put on an intermittent reinforcement schedule. During this experiment an attempt to counter this was done by using a random number generator to make sure the sample sequence was as random as possible. However, the generator needed did not take the position habit into consideration well enough and responses was reinforced for that position on occasion. This means that the subject might have used more repetitions than needed it this was taken fully into consideration, having a failsafe if position habits occur (Skinner, 1938)

Whenever doing research on discrimination procedures in an applied setting there is a whole different set of challenges to account for compared to in an experimental setting. In an operant chamber the experiment can be strictly controlled and most affecting variables are known, accounted for and more controlled. It can also be done without any contact between the subject and the experimenter and without using time rearranging the training set up (Skinner, 1938). Controlling variables that occurs because of direct interaction, the environment or not being able to control time, food and water consumption can be a challenge. A manual set-up and hands on interaction between the experimenter means that the training might vary in duration, number of repetitions and breaktime.

Working in the daily environment also means that there is a risk of using too much time between each sample presentation because it might be difficult to rearrange the samples, meaning there is a good chance that the animal might either loose interest, walk away or start showing singes of frustration or other alternative behavior. In an experimental setting none of these factors needs to be considered. There the animal is placed in the operant chamber and subjected to the procedure without any human errors or influence. This experiment tried to take this into consideration as much as possible. All training and handling were attempted done as similar as possible as a part of the daily routine.

Another common problem with manual procedure are the occurrence of is what is known as the Clever Hans syndrome, named after the horse Hans that was known for his ability to count while he was actually reading peoples body language, giving people a false impression of his ability. The Clever Hans Syndrome is basically the effect a human experimenter or handler has on the animals response based on body language. The animal learns to respond with a correct sample based on body language and the intended S^D. This is more relevant during the simultaneous procedure than the successive and the best way to counter this is to either cut down on direct contact during intervention. If this is not possible it is important to be able to control for body language by always making sure to not make any sounds, movements, eyeglances and so forth that might give the animal a clue as to what the correct response is (Heinzen et al, 2015). There is no clear evidence that this might be an affecting variable during any of these experiments, however it needs to be considered.

In terms of generalization studies have found that animals can easily generalize stimuli to new settings or new methods as well as to new novel stimuli. For instance, pigeons can discriminate art and generalize it to new novel samples (Watanabe et al 1995: Watanabe, 2001), jungle crows can generalize shape discrimination to new novel shapes (Bogale & Sugita, 2014) and dogs are able to generalize scent discrimination to new settings (Schoon et al, 2014).

Unfortunately, no studies specifically comparing the generalizing effect between simultaneous and successive procedure have been found. Even though this current experiment 1 did not give any final conclusion about generalization effect of the procedures switch, a hypothesis based on literature on the general subject generalization is that successive discrimination would yield a better generalizing effect (Skinner 1938: Cooper, 2007: Catania 2013). This was backed up with the results shown in experiment 2 where two of the animals was subjected to a reversal. The animal transitioning from simultaneous procedure to successive had more error compared to the one that transitioned to simultaneous from successive. The animal that was switched from successive to simultaneous had 100% correct responses. Based on that we can make the assumption that in an applied setting, were it would be a preferred advantage to be able to create generalization like that the preferred procedure would be the successive procedure.

In conclusion, both experiments indicate that all animal subjects were fully able to learn to discriminate between three sample stimuli. Both experiments show that individuals trained simultaneously uses on average fewer sample presentations then those trained successively. Both experiments also agree that the successive procedure produce more unwanted behavior in relation to the S^{Δ}. Unfortunately, only experiment two was able to do a switch in procedure to look at the generalization effect of the discrimination. Based on only one pair of animals we can only hypothesize but the results give a strong indication that successive procedure gives a wider generalization than successive. This needs to be investigated further.

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Tables

	Total R	Mean R	Total S^D	Total S^D-R	S^D Not R	Total S^Δ	Total S^Δ-R	S^Δ- Not R	Total CR
Tiger 1	290		290	188	102	580	102	478	188
Tiger 2	390		199	199	0	191	131	60	330
Gibbon 1	460	375	460	314	146	1290	146	1144	314
Gibbon 2	810	600	335	335	0	475	245	230	565

Table 1 Lists the total number of S^D and S^Δ the subject was subjected to, the total responses to the S^D and S^Δ, the total number S^D and S^Δ not responded for all four subjects. It also lists the total correct responses for each subject. Tiger 1 and Gibbon 1 was subjected to simultaneous procedure while Tiger 2 and gibbon 2 was subjected to successive procedure. It also lists the mean number of responses between the two procedures with 375 being the mean number for the simultaneous and 600 being the mean for successive.

	Agression		Stess realted		Leaving		M
	B	I	B	I	B	I	
Tiger 1	1	9	0	0	0	1	
Tiger 2	0	4	2	8	1	4	
Gibbon 1	0	0	0	0	0	1	6
Gibbon 2	0	3	0	15	2	3	21

Table 2 Lists the total occurrences of unwanted behavior such as aggression, stress related behavior or leaving, for all four subjects. The B column represents baseline and the I column represents the intervention. It also lists the mean number of unwanted behaviors, based on trails of ten, for both simultaneous, Tiger 1 and gibbon 2, and successive, Tiger 2 and Gibbon 2.

	Aggression S^D	Stress S^D	Leaving S^D	Other S^D	Aggression S^Δ	Stress S^Δ	Leaving S^Δ
Tiger 1	0	0	0	0	9	0	1
Tiger 2	0	0	0	0	4	8	4
Gibbon 1	0	0	0	0	0	15	1
Gibbon 2	0	0	0	0	3	0	3

Table 3 Lists the occurrences of unwanted behavior based on if it occurs after or during the presentation of the S^D or the S^Δ.

		Baseline			Intervention		
Tundra	Placement	1	2	3	1	2	3
	Amount	33	43	74	92	66	132
Erik	Placement	1	2	3	1	2	3
	Amount	29	78	43	91	224	145

Table 4 Lists the placement, or position, preference for both subject subjected to the simultaneous procedure, Tiger 1 and Gibbon 1, during baseline and intervention. 1-3 goes from left to right and the amount is the total responses to that specific position.

	Total R	Mean R	Total S^D	Total S^D-R	S^D Not R	Total S^Δ	Total S^Δ-R	S^Δ- Not R	Total CR
Goat 1	200		200	128	72	400	72	328	128
Goat 2	460		187	187	0	273	164	109	296
Goat 3	410	350	410	230	180	960	210	750	230
Goat 4	480	470	199	199	0	281	184	97	279

Table 5: Lists the total number of S^D and S^Δ the subject was subjected to, the total responses to the S^D and S^Δ, the total number S^D and S^Δ not responded for all four subjects. It also lists the total correct responses for each subject. Goat 1 and 3 was subjected to simultaneous procedure while Goat 2 and 4 was subjected to successive procedure. It also lists the mean number of responses between the two procedures with 350 being the mean number for the simultaneous and 470 being the mean for successive.

	Aggression		Stress related		Leaving		Other		M Per P
	B	I	B	I	B	I	B	I	
Goat 1	0	0	0	3	0	0	0	0	
Goat 2	0	0	0	9	0	6	1	13	
Goat 3	0	0	0	7	0	1	0	2	7
Goat 4	0	11	0	1	0	2	0	12	27,5

Table 6: Lists the total occurrences of unwanted, aggression, stress related behavior or leaving, for all four subjects. The B column represents baseline and the I column represents the intervention. It also lists the mean number of unwanted behaviors, based on trails of ten, for both simultaneous, Goat 1 and 3, and successive, Goat 2 and 4.

	Aggression S^D	Stress S^D	Leaving S^D	Other S^D	Aggression S^Δ	Stress S^Δ	Leaving S^Δ	Other S^Δ
Goat 1	0	3	0	0	0	3	0	0
Goat 2	0	0	0	13	2	9	6	13
Goat 3	0	7	0	0	0	7	1	3
Goat 4	0	0	0	0	11	1	0	12

Table 7: Lists the occurrences of unwanted behavior based on if it occurs after or during the presentation of the S^D or the S^Δ.

		Baseline			Intervention		
Tundra	Placement	1	2	3	1	2	3
	Amount	33	43	74	92	66	132
Erik	Placement	1	2	3	1	2	3
	Amount	29	78	43	91	224	145

Table 8: Lists the placement, or position, preference for both subject subjected to the simultaneous procedure, Goat 1 and 3, during baseline and intervention. 1-3 goes from left to right and the amount is the total responses to that specific position.

Figures

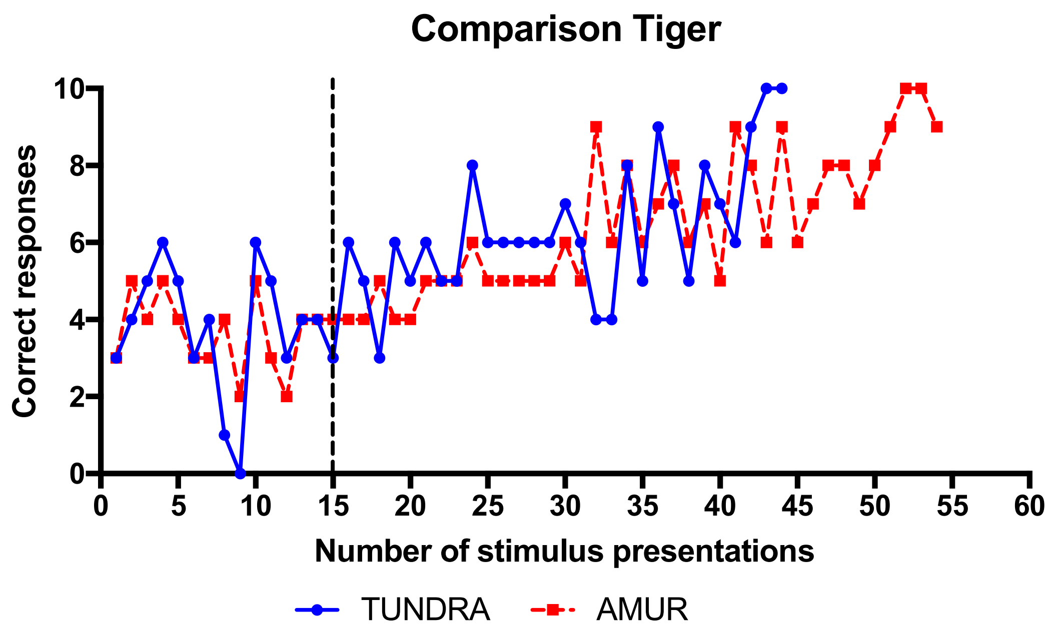

Figure 1: Show the comparison between the total sample presentations between the two tigers. The blue line, represents the female, Tundra, subjected to the simultaneous procedure. The red line represents the male, Amur, subjected to the successive procedure. The x axes represent the number of correct responses per ten sample. Y axes represent the total number of sample presentations

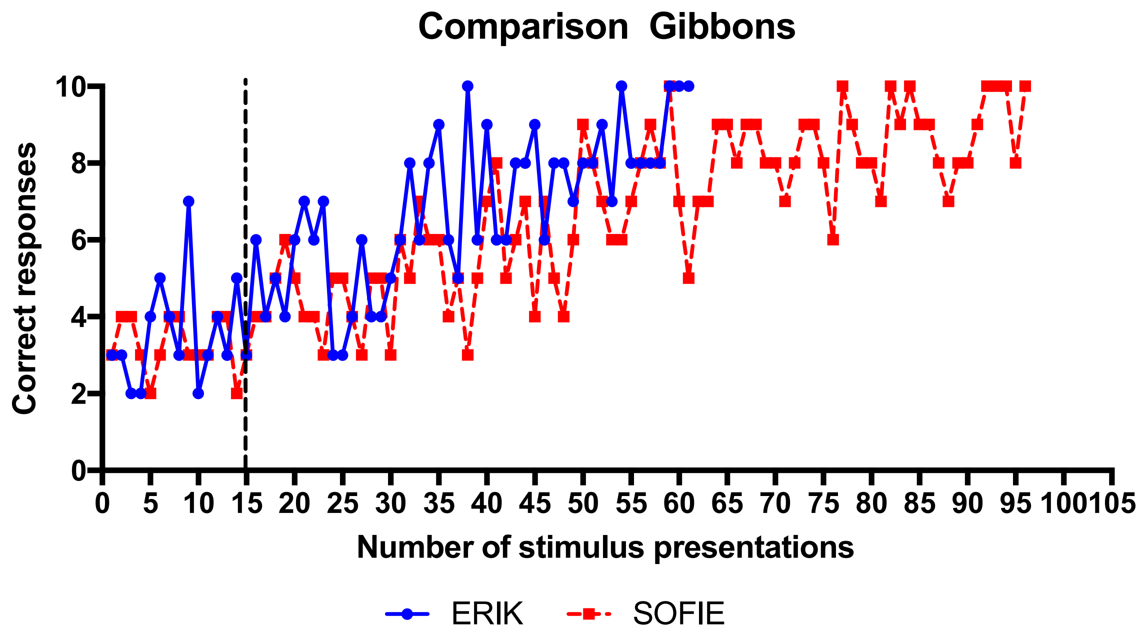

Figure 2: Show the comparison between the total sample presentations between the two gibbons. The blue line, represents the male, Erik, subjected to the simultaneous procedure. The red line represents the female, Sofie, subjected to the successive procedure. The x axe represents the number of correct responses per ten sample. Y axe number represent the total number of sample presentations

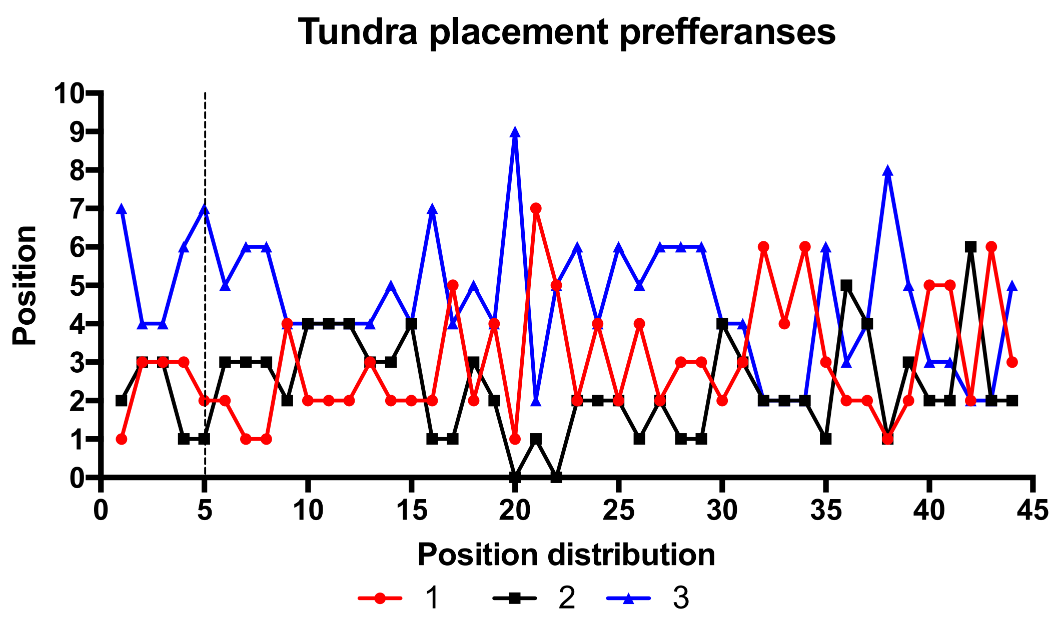

Figure 3: Shows the placement preferences for the female tiger, Tundra, during the simultaneous procedure per ten sample presentations. The x axes represent the position choices while y represent the position distribution.

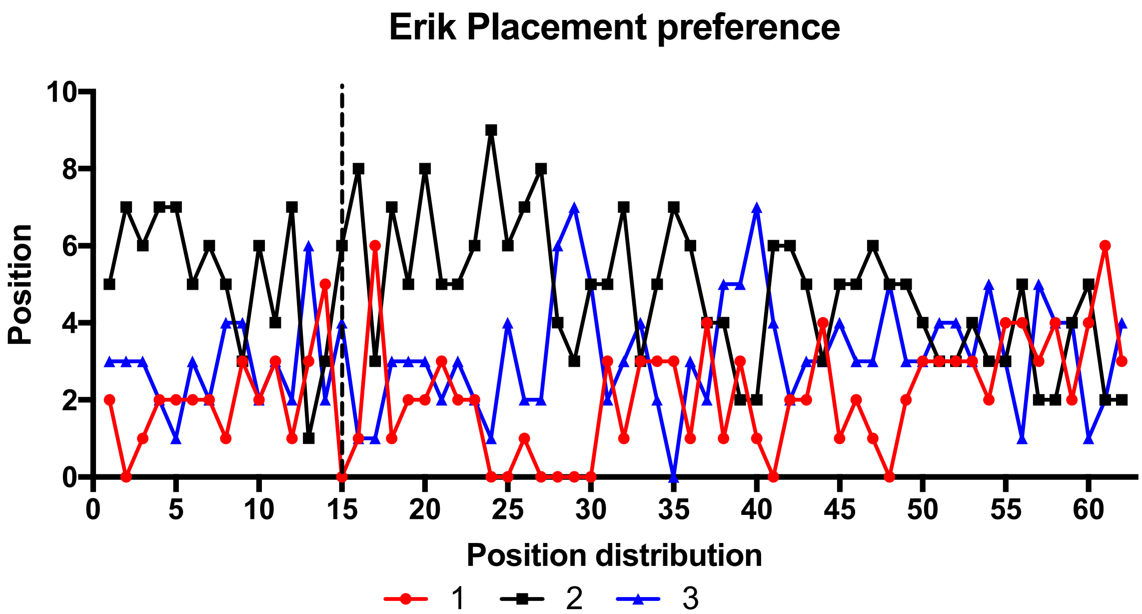

Figure 4: Shows the placement preferences for the male gibbon, Erik, during the simultaneous procedure per ten sample presentations. The x axis represent the position choices while y represent the position distribution.

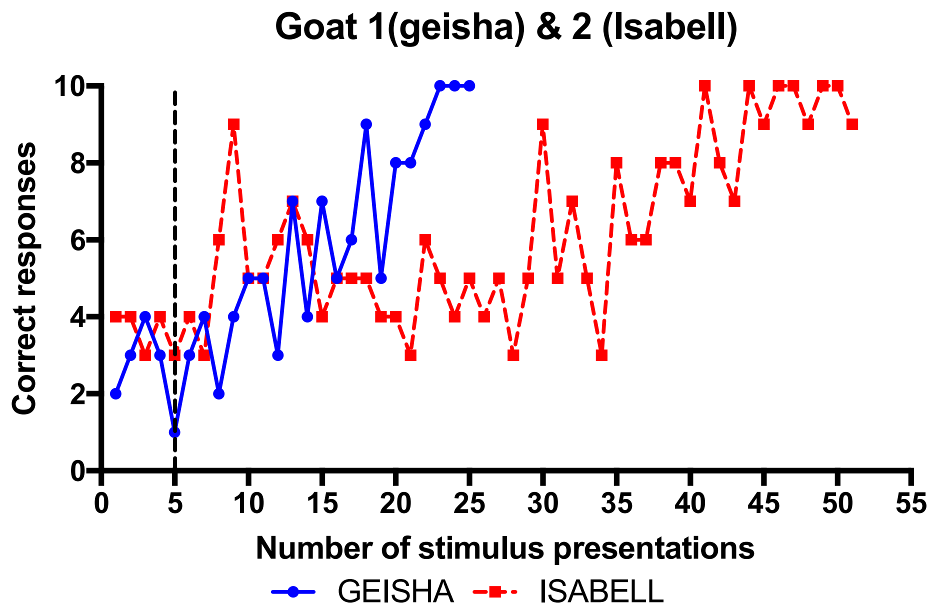

Figure 5: Show the comparison between the total sample presentations between goat 1, Geisha, and 2, Isabell. The blue line, represents the female, Geisha subjected to the simultaneous procedure. The red line represents the female, Isabell, subjected to the successive procedure. The x axis represents the number of correct responses per ten sample. Y axis number represent the total number of sample presentations.

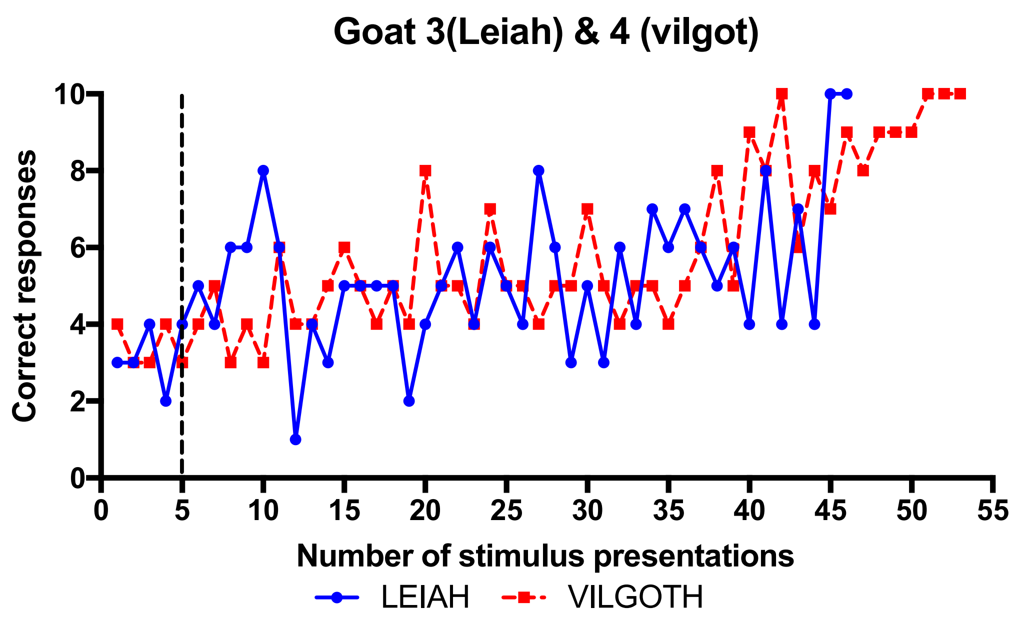

Figure 6: Show the comparison between the total sample presentations between goat 3, Leiah, and 4, Vilgot. The blue line, represents the male, Leiah, subjected to the simultaneous procedure. The red line represents the male, Vilgot, subjected to the successive procedure. The x axis represents the number of correct responses per ten sample. Y axe number represent the total number of sample presentations.

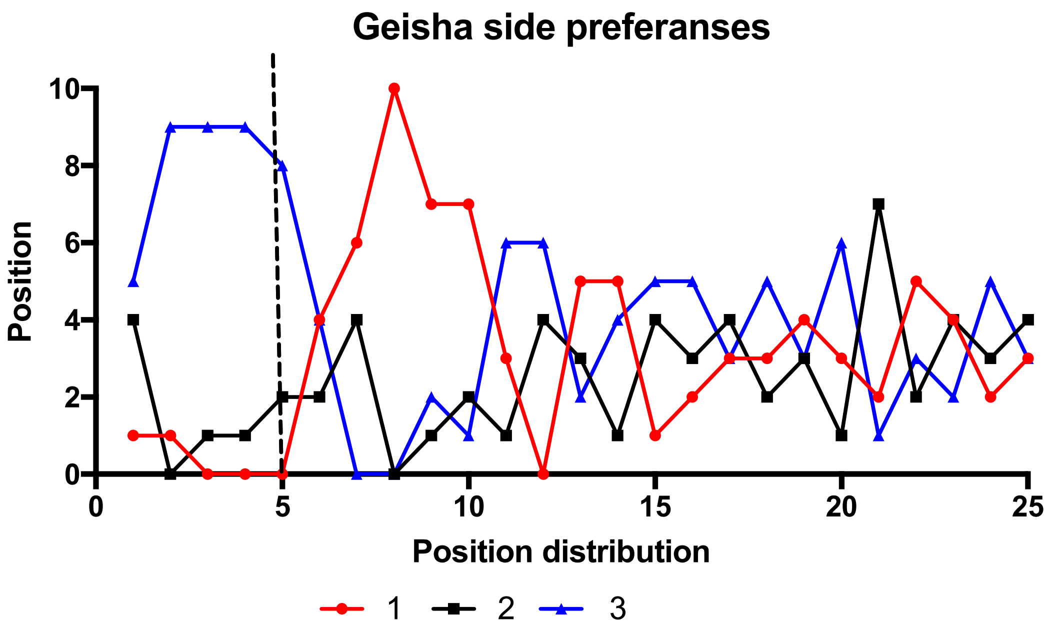

Figure 7: Shows the placement preferences for goat 1, Geisha, during the simultaneous procedure per ten sample presentations. The x axis represent position distribution the while y represent the position choices

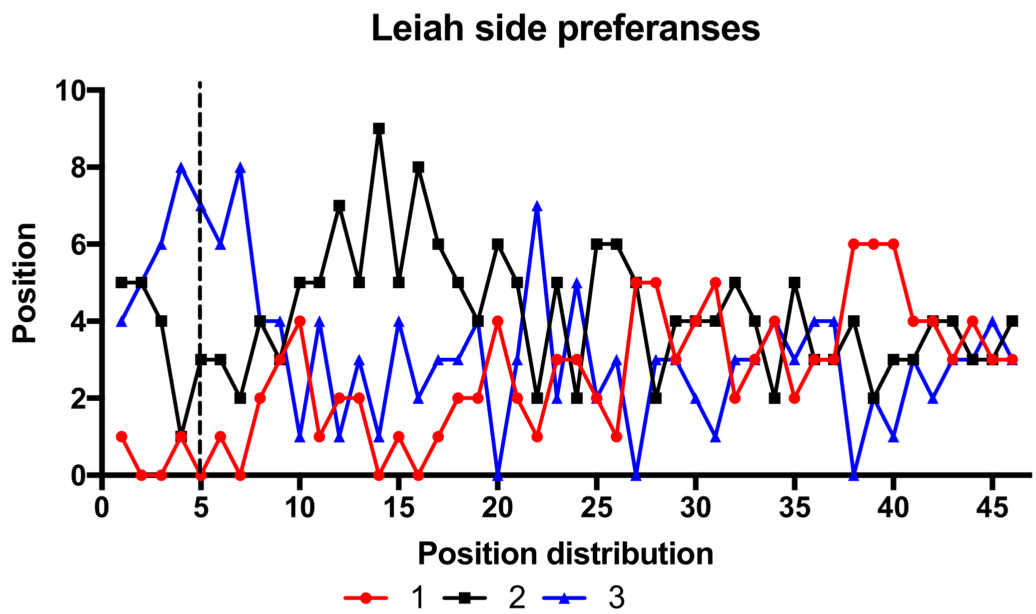

Figure 8:

Figure 8: Shows the placement preferences for goat 3, Leiah, during the simultaneous procedure per ten sample presentations. The x axis represent position distribution the while y represent the position choices

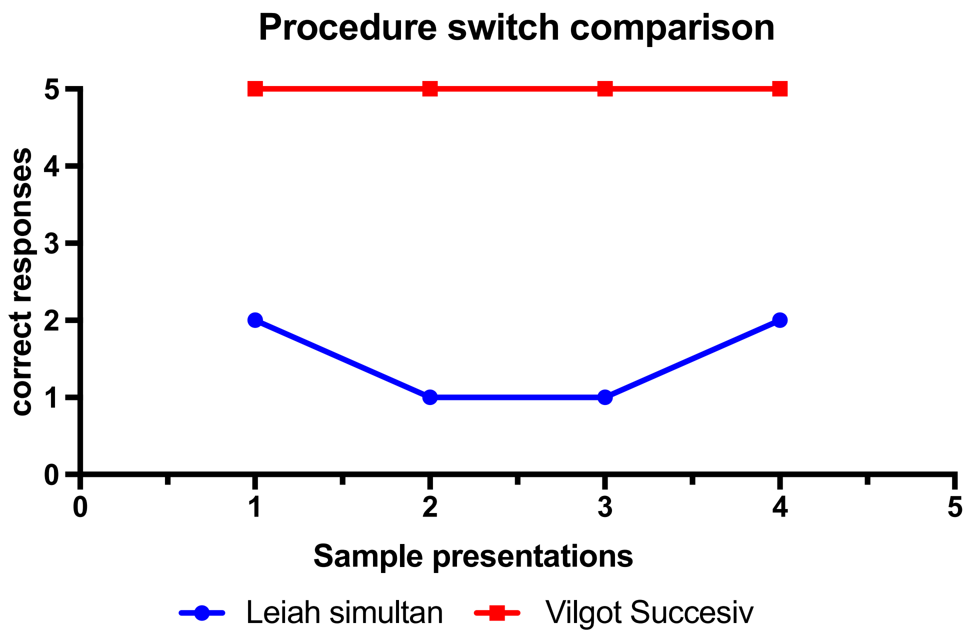

Figure 9: Shows the correct responses, after switching procedure, made by goat 3, Leiah, and goat 4, Vilgot, after switching procedure. The blue line represents Leiah when subjected to successive procedure. The red line represents Vilgot when subjected to simultaneous procedure. X axis represents the number of correct choices per five sample presentations and y represent number of sample presentations.