Two Procedures for the Establishment of Conditioned Reinforcers

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CONDITIONED REINFORCERS: A REVIEW

Abstract

As a science progresses, it is possible that some of its defining concepts might be overlooked, and this might necessitate later research and review to clarify what was known and what is currently known of its concepts. An example is the concept of conditioned reinforcers in the science of behavior. The concept once merited whole books but has now been relegated to mere mentions and paragraphs or chapters. This might be because there is a possibility that behaviorist are comfortable in their knowledge that they can establish them at will and as such need not delve further into it. This article reviews literature that presented two possible procedures for experimentally establishing conditioned reinforcers: brief pairings and operant discrimination procedures. The literature review suggests that brief pairings may yield conditioned reinforcers, but these may be short lived. Operant learning procedures, however; seem to establish conditioned reinforcers more effectively. The review also sheds light on some defining properties of conditioned reinforcers. Based on literature reviewed pointing to a possible short comings in brief pairing and the apparent effectiveness of operant discrimination procedures, the article concluded that, there was a need to open research into the establishing procedures of conditioned reinforcers.

Key Words: Operant Discrimination Learning, Briefly Paired Stimuli, Conditioned Reinforcement.

Towards a Definition of Concepts: An Introduction

Defining Reinforcement:

Thorndike, considered by some psychologist to be one of the first behaviorists, forwarded an explanation for his Law of effect. His explanation suggested that some events, usually those that one would expect to be pleasant seemed to "stamp in" a response that had just occurred. Noxious events, he continued, seemed to "stamp out" the response, or make it less likely to occur. Nowadays, these processes have been properly defined and termed reinforcement and punishment, respectively. Thus, Thorndike's Law of Effects says that

> "Any act which in a given situation produces satisfaction becomes associated with that situation, so that when the situation recurs the act is more likely than before to recur also. Conversely, any act which in a given situation produces discomfort becomes disassociated from that situation, so that when the situation recurs the act is less likely than before to recur also" (Thorndike, 1905, p. 203).

The concept of reinforcement has long been realized as an integral part in the considerations of any behavioral explanations. In a lay term vocabulary, it was synonymously related to *reward.* This synonymous relation between the term reinforcement and reward was dropped along the line. A reward is defined as (a) an act performed to strengthen approved behavior benefit resulting from some event or action; (2) to act or give recompense in recognition of someone's behavior or actions (www.dictionary.com). Thus as explained by Catania (1992), reinforcement is the response-produced presentation of positive reinforcers or the termination of negative reinforcers (or the increase or maintenance of responding resulting from this operation). He continues to point out that reinforcers are stimuli whilst reinforcement is the operation and that the operation reinforcers responses not the organism

and that, organisms at best are rewarded; but the concept of rewarding alludes to effects of stimuli other than reinforcing effects.

In as much as the relationship between the two terms, reinforcement and reward, was discarded by behavior analyst, cognitive psychology commits the categorical mistake (Ryle, 1949; Holth, 2001), of using them synonymously. Cognitive theories view rewards as a concept for describing the positive value an individual ascribes to an object, behavioral act or an internal physical state. Furthermore, primary rewards include those that are necessary for the survival of the species, such as food, water, and sex; sometimes even pushing for the inclusion of shelter in primary reward class. It considers secondary rewards as deriving their values from the primary reward and includes money, pleasant touch, beautiful faces, music etc. The functions of rewards are based directly on the modification of behavior and less directly on the physical and sensory properties of rewards. Rewards induce learning, approach behavior and feelings of positive emotions. In the science of behavior, reinforcement has long been dissociated from the lay term of rewards. It is an integral part of the change process and a major concern of behavior analysts. In their book, *Techniques and Guidelines for Social Work Practice,* Sheafor and Horejsi (2005) explained reinforcement to be any event or activity that increases the likelihood that a target behavior will occur more frequently. Thus a reinforcer to them is anything that strengthens a target behavior. Another Social Work book indicates that it is any contingency that increases the probability that a respondent will perform a behavior (Toseland & Rivas, 1995). The two books recognize the term as composed of a positive and a negative. The explanations forwarded by these authors indicate an attachment to the reward concept. Explaining negative reinforcement, Sheafor and Horejsi (2005), compared it with positive reinforcement and suggested that unlike positive reinforcement that increases behavior through “rewards”, negative reinforcement involved the

subtracting or removal of some condition that is aversive or unpleasant to the client, which has the effect of increasing or strengthening target behavior. Reinforcer, as defined in most *introductions to psychology* books, is the presentation of an appetitive stimulus (positive reinforcement) or the reduction or removal of and aversive stimulus (negative reinforcement) that is contingent on a response. They further reiterate that reinforcement increases the frequency of the response (Carlson, 1993). It is true that the above definitions touch on salient aspects of the term reinforcement, but it is still necessary to present a definition suggested by the science of behavior. In its earlier stages of evolution, the term was also applied to the presentation of unconditioned stimulus in respondent conditioning, but that usage is now considered unusual (Catania 1992). Catania (2007) reiterated his earlier point (Catania 1979) and one agreed on by O'Donohue (1998) on discussing the term, suggested that a satisfactorily definition of reinforcement, must satisfy at least three things. The first he suggests is that an action must lead to a consequence; and that on the basis of its consequence, the action must subsequently become more frequent; and finally, that the increase in frequency must be due to arranging the consequence to follow the action, not merely to its presentation (in Catania, 2007). Pierce and Cheney (2004), also suggest that it be seen as "an increase in the rate of operant behavior as a function of its consequences". They continue to say that it is also the procedure of presenting a reinforcing event when response occurs. Cooper, Heron and Heward (1997), defined reinforcement as a process that occurs when a stimulus change immediately follows a response and increases the future frequency of that type of behavior in similar conditions. Finally, Catania (1992; 2004) has suggested that the term be seen as the response-produced presentation of positive reinforcers or termination of negative reinforcers (or the increase or maintenance or responding resulting from this operation). Thus, reinforcement is an operation which reinforces responses, not organisms;

organisms are sometimes said to be rewarded but this term often implies effects of stimuli other than reinforcing effects.

Practical Explication of Reinforcement

Having read a lot of published articles and books in the course of writing this thesis, I have come to realize that sometimes the technicalities of these articles hinder their dissemination and understanding to the lay man. Surely we write not only for the academia, but also for the "man on the streets", for is not one of the goals of behavior analysis, to help improve appropriate behavior whilst reducing social non-conformity? This section aims to present daily interactive examples of the concept of reinforcement and reinforcer such that it becomes simple and easy for the lay man to grasp. There will be a presentation of an example or two followed by an analysis of it to show its relation to the concept of reinforcement

Secondary and Primary Reinforcers an Explanation.

At the time that B. F. Skinner was hit by the enchantment (see Wilson 1998 for a thorough discussion of the Ionian Enchantment), Pavlov was doing work in the area of classical conditioning, the idea that everything starts with a reflex. His premise was that there are certain unlearned stimuli that you respond to without being taught.

Unconditioned stimulus (UCS) ⟶ Unconditioned response (UCR)

Coupled with the idea that there are unconditioned stimuli, Pavlov recognized that there are also neutral stimuli that do not produce a response. When the neutral stimulus is paired with a UCS, the neutral stimulus becomes a conditioned stimulus. Pavlov was interested in what would happen if given an UCS and an UCR, would a neutral stimulus presented immediately before the UCS eventually lead to the response?

Unconditioned stimulus (UCS) ⟶ Unconditioned response (UCR)

Conditioned stimulus (CS) ⟶ Conditioned response (CR)

There are two important factors that can affect how efficiently the relation between the conditioned stimulus and unconditioned stimulus is learned; thus the timing between the CS and the UCS coupled with the strength of the stimulus are the important factors. As Skinner pointed out and echoed since by various authorities, if there is a long time between the presentation of the CS and the UCS, the connection between the two will be weak affecting; of course this is a not just a lay analysis of the functional relations that comes into play in learning, empirical data also shows this pattern. The focus of this paper though centered on learning is not on the molar issues, but at what happens at a molecular level of learning; basically, the components and how they interact to ensure a final repertoire; product. In this sense, then, what comes to mind is the stimulating variables and how these interact with the individual to evoke a response and the contingencies that develop from these interactions along a reinforcing path. This section of this paper seeks to highlight stimuli and how they enter into the vocabulary of reinforcement in a response-consequence relation. The events or stimuli that increase the likelihood of reoccurrence of the response in question are known as reinforcers. The reinforcing stimulus has been defined; in an operant concept; as the stimulus that reinforces the operant (Atkinson, 1987). Bower and Hilgard (1981) explaining reinforcers point out that "a reinforcer is defined by its effects; any stimulus is a reinforcer if it increases the probability of a response". Donahoe and Palmer (2004) forwarding a selectionist perspective on reinforcers, explained it as an eliciting stimulus that functions to select environment-behavior relations. In the behavioral literature, reinforcers are seen as stimuli with the functional effect of reinforcement of responses. The stimuli that happen to act as reinforcers fall into two main classes; primary and secondary (see Skinner, 1953; Donahoe & Palmer, 2004; Catania, 2007).

Primary reinforcers

Definitively, primary reinforcers are reinforcers or stimuli that enter into a reinforcing contingency in which the effectiveness of the stimulus does not depend on its contingent relation to another reinforcer (Catania, 1994). In other words then, a primary reinforcer is a reinforcer that is biologically pre-established to act as reinforcement, with food, water, and sex being examples of events or situations or stimuli that maybe considered as primary reinforcers because they satisfy contingencies of survival. But then, a stimulus or event *intended* as a reinforcer may not *function* as a reinforcer. One must measure its effects on a response in order to establish its functional relation to that response. Thus a primary reinforcer can be defined as a stimulus or event that satisfies a biological need (e.g., hunger; thirst. the argument then agrees that, any reinforcement value that occurs naturally, and appears to meet basic primary needs meets a definition of what a primary reinforcer is. The reinforcing effect of a primary reinforcer then is automatic, inborn, and does not depend on learning history. Practically then primary reinforcers are environmental events that a responding organism instinctively and inherently finds rewarding. No learning is necessary for these reinforcers to increase the likelihood of a response occurring again due to its presence or absence.

Secondary Reinforcers

Catania (1994) pointed out that, reinforcers are distinguished on the basis of the operations that establish them. Thus a conditioned reinforcer is one that has become effective by virtue of its relation to some other reinforcer (e.g., money). Likewise, a reinforcer that depends on no such relation is called an unconditioned reinforcer (e.g., primary reinforcers). Donahoe and Palmer (2004) based their definition of conditioned reinforcers on their functional relation to a response with an emphasis on the establishing operation involved in

the conditioning. Thus they present a definition that sees conditioned reinforcers as stimuli that functions as reinforcers in operant procedures as a result of having been paired with other reinforcers. And thus any stimulus that has achieved an evocative function as a result of a paired relation to an eliciting stimulus becomes a conditioned stimulus. Skinner saw the definition of conditioned reinforcers in terms of a previously neutral stimulus that has become reinforcing to an organism's behavior through association with another reinforcer (Skinner, 1938).

From the discussion so far, it is clear then the conditioned reinforces are merely environmental events which by virtue of some training procedure or learning history have come to acquire reinforcing qualities.

Some Examples of Conditioned Reinforcers:

At an empirical level, there can be little doubt that experimental operations in which once-neutral stimuli are contingent on operant behavior may substantially affect both rate and pattern of that behavior.

Non-Verbal Stimuli: Token Economy

By definition tokens as conditioned reinforcers are any elements of a stimulus that by virtue of a conditioning program has acquired reinforcing properties; and when earned for exhibiting target behaviors may be exchanged or traded for a primary reinforcer or a consumable reinforcer. Though the consumability of the trade-off stimuli may not be eminent as in some instances the trade might result in the acquisition of some different tokens, but they eventually culminate in an exchange for primary reinforcers. They however have the ability to maintain a response pattern especially in chain schedules until the final link that produces the reinforcer. Jackson and Hackenberg (1996) suggested that tokens may function

as conditioned reinforcers, although their discriminative properties may be responsible for the self-control that occurs under token reinforcer arrangements.

Tokens begin essentially as neutral stimuli, of little significance in and of themselves. However, as the tokens become increasingly associated or correlated with primary reinforcers for which they are exchanged, they become reinforcing. Examples may range from money to stones, as already explained the value or effectiveness of a token as a reinforcer lies in the importance of the primary reinforcer associated or correlated with them; the difficulty in the response upon which they are contingent and also the experimental design that establishes it as a reinforcer.

No matter what form a token might take, it must possess some general qualities. One of them being the quality of visibility and or being countable. The concept of conditioning has been argued to work so far as the respondent is attending to the stimuli in use in the conditioning procedure; thus in a token economy or in the use of tokens as reinforcers; stimuli yet to be conditioned must be of a physically accessible entity. Conditioned reinforcers; (even in the case of generalized reinforcers) do need a specific response on which they are contingent. In the absence of response specificity, the value of a token as a reinforcer becomes ambiguous and thus diminishes or becomes ineffective to evoke the desired response. Some examples of tokens may be generalized reinforcer" like money, buttons, and poker chips etc.

Verbal Stimuli

When Nelson Mandela of South Africa was imprisoned, without access to human beings, he turned to other creatures (insects; see Long Walk to Freedom, 1995); for a means of conversation. Man (and most organisms) is inherently a social animal; though this relies heavily on the social upbringing of every one. As we grow older we acquire a large response repertoire which is established if not solely, largely through discriminative training. The basic stimuli in this social class room are verbal in nature. Lovaas et al (1966) have shown that

verbal stimuli or cues can be established as reinforcers not by pairing by but discriminative training.

In the language of conditioned reinforcers, verbal cues taken as stimuli can be conditioned to evoke desired responses, but they must have the ability to abstract to the existing repertoire of the responding organism. For how good will the grade "A" be to a person who is not in school nor in any academic field; unless he is the one paying for the respondent partaking in the academic endeavor, and even then it does serve as a conditioned reinforcer for evoking responses of a topography classified as "pleased or happy and proud", which may yet lead to other responses aimed at the initial respondent to emit the initial responses that produced the "A grade" again and again.

Tacts, Mands, and all forms of verbal behavior can serve as cues in a discriminative training procedure where they tend to acquire reinforcing properties. A mother uses the word or phrase "*good boy"* to appreciate (in lay terminology) a son's emission of a desired response; and "*naughty boy"* when the response is not the desired one. Over time, the phrases "*good boy"* and "*naughty boy*" become conditioned reinforcers for the child by virtue of discrimination learning. Yes in this instance as is the instance of most complex responses, discriminative learning is of a chained nature.

How Conditioned Reinforcers Can Be Established

Is Pairing the Answer?

Previous sections of this article have already outlined the defining variables in a conditioned reinforcer. What still needs analysis and clarification is the question of establishing procedures; for there seems to be two schools of thought, one of a paired or correlated stand and another of a discrimination training stand. The current school of thought on the issue holds that conditioning occurs through a "paired" relation or a "discriminative" instance. The paired relation holds the longer side of the rope. Advocates of this school may

not be faulted for doing so; considering the roots of conditioning. This section will seek to review the some articles and literature that presents experimental designs for establishing conditioned reinforcers and also present why behavioral scientist need to re-investigate establishing concepts for conditioned reinforcers. Pryor, (1984**)** has explained that practical animal training that uses positive reinforcement should almost always begin with the establishment of a conditioned reinforcer. Before the start of any real training of behavior, while the subject is doing nothing in particular, you teach it to understand the significance of the conditioned reinforcer by pairing it with food, petting, or other real reinforcement. Pryor's statement brings forth the importance of conditioned reinforcers to behaviorists as we seek a further analysis of behavior.

Generally, in a rat based experiment; with novice rats; the rat must be habituated with the experimental chamber following which it is magazine trained. Davol, Steinhauer and Lee (1977), present a good explanation of magazine training of pigeons, though they conclude in their analysis that autoshaping readily occurred when the chamber was continuously illuminated by a house light. This accession may hold true not because the light maybe serving as a major component but because pigeons are sight-enabled responding participants unlike rats who might not need illumination in magazine training. Also their explanation makes use of a paired paradigm, but then it holds that the light tends to serve as a discriminative condition for the birds as it does for rats (possible magazine sounds or smells) that food maybe available. Though discrimination in this sense does not signify a stimulus-response-reinforcer relation it does serve to present an instance when reinforcement is available and is not.

Grant and Evans (1994) have pointed out that conditioned reinforcers, also called secondary reinforcers, acquire their reinforcing effectiveness through a learning process in

which they are associated with other reinforcers. A point supported by Martin and Pear (1996) who explained that specifically, stimuli that are not originally reinforcing can become reinforcers by being paired or associated with other reinforcers. Stimuli that become reinforcers in this way are called conditioned reinforcers

In studying conditioned reinforcers, the most common approach is exemplified by the work of Myers and Myers (1964, 1965, 1966), which has been to pair a stimulus with reinforcement on a small number of trials and then measure the effects of the stimulus upon resistance to extinction. That is, if a primary reinforcer is presented in the presence of a stimulus without being dependent on a designated response, that stimulus can still be a conditioned reinforcer (cf. Kelleher & Gollub, 1962). According to these experiments, stimuli need only be paired with primary reinforcers to function as conditioned reinforcers. Such an experiment is that reported by Nunnally et al (1965). Their experiment sought to investigate the effects of pairing of a neutral stimulus to a primary reinforcer. Three experiments were reported concerning the conditioning of verbal evaluation and eye movements in children. Conditioning was obtained with various payoff games in which neutral stimuli were paired with rewards in a stimulus-stimulus conditioning model. After conditioning, children attended more to the pay-off stimuli more than nonpay-off stimuli (Nunnally et al 1965). They used a simple stimulus-stimulus procedure. In their report, the design was the pairing of neutral stimuli (CSs) with rewards (UCSs). Even though Nunnally et al (1965) and Myers and Myers papers have all reported successes, they also report a low reinforcer strength in the conditioned reinforcer.

On the basis of the reported results, Birnbrauer (1971) conducted a series of experiments on conditioned reinforcers to determine if pairing a stimulus with reinforcement effects an increase in the reinforcement value of the stimulus when the test of reinforcement value is

strengthening and maintaining a response. He rationalized that, having observed that a nonsense word does not maintain a response, would its function change to that of a positive reinforcer when it has being paired with primary reinforcement in another component of a multiple schedule? The results of Birnbrauer (1971), suggest that temporal forward pairing of a stimulus with reinforcement (assuming that stimulus-attention prevails) temporarily enhances its reinforcement and probably its cue value as well, but maintaining behavior or increasing behavior with that stimulus depends upon the role that the behavior plays in producing primary reinforcement.

In the quest to explain and refine designs for conditioning secondary reinforcers, a lot of concepts or combination of schedules have been used, one of this is that of concurrent chains. It is true that chaining presents a discriminative argument, but Gollub presented a a doctoral thesis by S. M. Autor which described a long series of studies on concurrent chains in relation to pairing and conditioning.

In Autor's procedure, two keys were available to the subject (generally a pigeon). At the beginning of each sequence, both keys were lit. As determined by equal but independent intermittent schedules, a peck on one key terminated the period of concurrent response alternatives (the initial links). In Autor's experiment, as in most of the other research on concurrent chained schedules, each of the initial links had a variable-interval (VI) schedule associated with it. A peck after a certain period of time, determined by the irregular series of the VI schedule, terminated the presentation of both concurrent initial links. A food reinforcement schedule was then in effect for pecks on that key (the terminal link), and the other key was dark. After a period of time during which food reinforcements were delivered, the sequence began again with the concurrent initial links. The two food-reinforcement schedules in the terminal links were generally the major independent variable of the

experiment (Gollub, 1970). Gollub explains that the rationale behind concurrent chains in pairing based designs is that the relative frequency of responding on the two keys during the first links are used as a measure of the relative strength of the conditioned reinforcers which controlled this responding. In other words, the reinforcing strength of a stimulus, in this case a conditioned-reinforcing stimulus, will be measured by the relative degree of responding which it maintained. The concurrent first links are thus treated in the customary manner for a pair of concurrent operants (Catania, 1966). Autor did achieve some success at conditioning, but then also his effects seemed to be non lasting.

Gollub (1970) and Kelleher and Gollub (1962) reviewed another important method for investigating conditioned reinforcement which involves the response-dependent presentation of a stimulus for a brief period of time. In this method, the major independent variable is the organism's history with respect to that stimulus-especially the occurrence of that stimulus in relation to delivery of primary reinforcers (food, water etc).

Gollub (1970), points out that research on reinforcement-paired brief stimuli has mostly relied on second-order schedules of reinforcement. M. J Marr (1969), in Gollub's (1970) review, is said to have integrated reinforcement paired brief stimuli with chained schedules; this integration, as pointed out by Gollub presents variables which are of important considerations in the analysis of the results based on this procedure. The first of these variables, as pointed out by Gollub, is that it presents specific temporal associations of the brief stimulus in relation to the experimental design; for example the minimal time between primary reinforcers. Thus, the primary reinforcer occurs with certain fixed temporal constraints that could affect behavior in ways complementary to or opposed to those of the component schedules. Another presenting variable of Marr's integrated design is that; the component schedule in a second-order schedule specifies a "behavioral unit" on which reinforcement is dependent. The question then is: Does the behavior generated by such

component schedules have a "unitary" character? Marr presented experimental illustrations on both sides of this question, and called for further experiments ". . . to determine the limitations of treating second-order schedule components as actual unitary responses" (Gollub 1970).

Stubbs (1971) reported an experiment in which he exposed thirteen pigeons key pecking to a variety of second-order schedules; in his experimental design, responding under a component schedule was reinforced according to a schedule of reinforcement. Under different conditions, completion of each component resulted in either the brief presentation of a stimulus; which is also present during reinforcement (pairing operation), or the brief presentation of a stimulus not present during reinforcement (non-pairing operation), or; no brief stimulus presentation (tandem). He obtained results showing that brief-stimulus presentations engendered a pattern of responding within components similar to that engendered by food presenting a case of conditioning. However, there were no observed apparent differences in performance under pairing and non-pairing conditions in any of the experiments. The conditioned reinforcer of the brief-stimulus operations produced an increase in response frequency in post-test but this increase was short lived. Stubbs reports an interesting result in one of his studies; in which, similar effects on performance were found whether brief-stimulus presentations were response-produced or delivered independently of responding; depicting no discrimination or conditioning properties on the stimulus in question. He concluded on the basis of his results that, a reevaluation of the role of conditioned reinforcement in second-order schedule performance was needed. After all, the similarity of behavior under pairing and non-pairing operations is consistent with two hypotheses: (1) the major effect is due to the discriminative properties of the brief stimulus; (2) the scheduling operation under which the paired or non-paired stimulus is presented can establish it as a reinforcer (Stubbs, 1971).

Many experimenters who have worked with pairing designs as a means of achieving a conditioned value of reinforcers have faced a myriad number of problems; which will be later discussed; but all seem to share the views of Lovaas et al. (1966). Lovaas and colleagues pointed out that although empirical evidence shows (Kelleher & Gollub, 1962) that one can

sometimes establish a previously neutral stimulus as an acquired reinforcer, via the classical conditioning paradigm (consistently associating a neutral stimulus with one which already has reinforcing properties). Yet, they failed to observe such effects in the two children with whom they worked. They report that they paired, in several hundreds of trials, the word ”good” with food delivery; but subsequent tests of ”good” for secondary reinforcing properties were negative; there were no modifications in the child's behavior when that behavior was accompanied by ”good.” It must appear then that there would be a need to look for alternative means of conditioning; and this they did. They turned to discriminative designs and success was achieved.

Discrimination an alternative to Pairing?

One must think by now that the establishment of conditioned reinforcers depends on a pairing procedure. In the early history of a an already young behavioral science, this would have been acceptable, but given what we know now, one needs to assess if this holds true. This pairing correlation associated to conditioned reinforcers may well stem from Skinner's initial analysis of the concept. Bower and Hilgard voices this by explaining that Skinner recognized conditioned reinforcers based on the pairing of neutral stimuli with primary reinforcers.

Based on experiments that have been conducted using chained schedules, we have come to discover that the intermittent chains tend to achieve a discriminative function which then controls subsequent responding and in most cases present the acquisition of conditioned reinforcer properties by components of the chains. This even hold in cases when the chains involve brief stimulus presentations, as presented by Catania (1994); he wrote that; the stimuli in chained schedules can become conditioned reinforcers, but they combine with discriminative effects in such a way that responding is reduced though he later explains that

response can be amplified if the introduction of brief stimuli is paired with that of second order-schedules which still presents a paring concept. But even in instances involving contiguous conditioning designs, an unplanned discriminative conditioning may surface.

Previous studies of conditioned reinforcement (see review by Kelleher & Gollub, 1962) and conditioned punishment (Hake & Azrin, 1965) has shown that a stimulus can be given enduring reinforcing or punishing properties by intermittent pairing with an unconditioned stimulus; this results in the establishment of a conditioned reinforcer; due to one of the links in the chain becoming a discriminative event for subsequent event(s). We cannot explain responding on these intermittently-paired-chains as due to the respondent "understanding" the design, this might hold for humans, but what of animals who are not on the same verbal plane as humans then? So their response on such chains may have one possible explanation, that the links; if not all, some; become conditioned secondary reinforcers established through discriminative conditions.

Fantino and Romanowich (2007) have reiterated the point that, there are other procedures responsible for the establishment of conditioned reinforcers other than a "paired" design. They recognize that conditioned reinforcement is a central concept in learning and motivation. Squires, et al (1975) present a scenario where the terminal link of a chain schedule presumably can be considered a conditioned reinforcer because it immediately precedes the delivery of food (an unconditioned reinforcer). However, the penultimate link is twice removed from food and would, if effective as a reinforcer, depend on pairings with a conditioned reinforcer. It may be that such higher-order conditioning does not produce effective conditioned reinforcers, and that this is why behavior is poorly maintained on extended chain schedules. But then they point out that in contrast, brief-stimulus presentations, which occur at the end of each component schedule, are intermittently paired directly with primary reinforcement and in principle tend to serve as effective conditioned reinforcers. But

then Stubb (1971) presented a somewhat different case which would counter their assertion, he found that brief stimuli also facilitate responding when presented at the end of each component, except the one preceding primary reinforcement. Squires et al. (1975) explain that these "unpaired" brief stimuli are presumably not conditioned reinforcers; consequently, their effectiveness in enhancing response rates weakens the conditioned reinforcement explanation outlined above.

Their explanative conclusion then was that there is considerable evidence from classical conditioning studies that the emission of a conditioned response is dependent on the context in which the conditioning occurs, and is not always a simple function of the relation between the conditioned and unconditioned stimuli. In a similar way, the relationship between responding and reinforcement on second-order schedules may not be the only determinant of response rate. Instead, the different stimulus conditions associated with these second-order schedules may result in the animal attending to different aspects of the situation and learning a different set of relations (Squires, Norborg, Fantino, 1975). This conclusion presents a situation of stimulus control and choice and how this affects response rate as well as how attending influences the conditioning of responses or stimulus; be it in a reinforcement based conditioning or response rate analysis.

Zimmerman (1960) in an earlier paper explained that Ferster and Skinner (1957) had referred to a similar schedule, which also involves intermittency in the S^D-reinforcement connection, *percentage reinforcement*. In percentage reinforcement, some of the reinforcements in an intermittent schedule are omitted and replaced by another event, which then functions as a conditioned reinforcer. Ferster and Skinner found that a fixed-ratio performance could be maintained under percentage reinforcement, but that the pauses became longer. In the Ferster-Skinner experiment the change was gauged by the reinforcing power of

the stimulus in maintaining a fixed-ratio schedule. Zimmerman (1960) suggested that the observed change in reinforcement rate using percentage reinforcement concept could be shown by an increase in latency and in variability of latency of the first response following the S^D; thus his experimental results are consistent with the finding that partial reinforcement in a runway tends to increase latency.

Despite this, animals in experimental designs based on this, still pressed the bar to produce the noise when nosing; a previously conditioned response; of the key was no longer required to end the shock and had long since extinguished. This suggested that previous theorizing (reviewed by Myers, 1958, and by Kelleher and Gollub, 1962) concerning the need to establish a stimulus as a discriminative stimulus for some response in order for it to function as a conditioned reinforcer was not valid. But then if this holds, then, it should be possible to simplify initial training procedures and establish a stimulus as a conditioned reinforcer without ever training the animals to make a response in its presence (Zimmerman, 1960) but this is not possible.

Neuringer and Chung (1967) concluded that, if a secondary reinforcer is defined in terms of its effects on behavior, then the neutral stimulus (white noise) used in their study can be said to have acquired some of the properties of the secondary reinforcer on the basis of their experimental design (see Neuringer & Chung, 1967, for a detailed description). But then, as pointed out by various writers, there is an important difference, between the experimental operations by which a secondary reinforcer is usually defined (e.g., Keller & Schoenfeld, 1950; Kimble, 1961; Kelleher & Gollub, 1962). In the current design, the previously neutral stimulus presented on a PR schedule never occurs at the same time as, or immediately before, the primary reinforcer; thus presenting a conditioned quasi-reinforcer. Technically, the secondary reinforcer is defined by a close temporal relationship between it and the primary reinforcer, the quasi-reinforcer is defined by an identity between its relation to behavior

(attending) and the relation of the primary reinforcer to behavior (operant contingencies). And whereas the secondary reinforcer denotes the occurrence of, or availability of, the primary reinforcer, the quasi-reinforcer denotes the non-occurrence of the primary reinforcer (a discriminative explanation, especially in chained schedules where the schedule achieves a reinforcing status, even when reinforcement is not contingent directly on it). Based on this, it is safe to voice Neuringer and Chung (1967), and Kelleher and Gollub, (1962) opinion that, a neutral stimulus does not necessarily have to occasion or accompany a primary reinforcer in order to acquire reinforcing properties of its own.

Dinsmoor and Clayton (1966), expressing their opinion on Neuringer and Chung (1967), and Kelleher and Gollub, (1962) statement, point out that; the finding that a stimulus can be established as a conditioned reinforcer without requiring the subject to make any response in its presence at any time to secure the primary reinforcer would seem to have important implications for the class of theories that assert that the effectiveness of a reinforcer depends on the strength of the behavior that occurs in its presence. Since termination of shock was used as the primary reinforcer; in the Dinsmoor and Clayton (1966) experiment, it was not even necessary for the animal to make a consummatory response in the presence of the stimulus, as in experiments in which food was used to maintain the behavior. They continue; in particular, these finding calls into question the generality of the suggestion (e.g., Keller & Schoenfeld, 1950) that utilization as a discriminative stimulus is a necessary condition for the establishment of a stimulus as a conditioned reinforcer. (see Kelleher & Gollub, 1962, for a review). The possibility that some form of respondent activity was elicited by termination of the shock and was conditioned to the onset of the noise, cannot, of course, be ruled out. Another loophole that would seem difficult to eliminate in this type of research is the possibility that some form of superstitious behavior (Skinner, 1948) may have become

established in the presence of the noise. The operation of pairing a reinforcer with a neutral stimulus involves repeated presentation of the reinforcer in the presence of the stimulus, and any form of behavior that is common in the presence of that stimulus will repeatedly be followed by the reinforcer. Thus, the noise may have come to serve as a discriminative stimulus for some such activity. It can be stated, however, that the reinforcing effect of the noise does not depend on the deliberate establishment of any operant or on the particular form of behavior that is maintained in its presence. Its discriminative properties alone should be enough to make it an effective reinforcer.

A number of writers (e.g., Dinsmoor, 1950; Keller & Schoenfeld, 950; Schoenfeld, Notterman, and Bersh, 1950) have suggested that in the appetitive case, at least, the effectiveness of a stimulus as a secondary reinforcer depends on its effectiveness as a discriminative stimulus for some behavior that produces the primary reinforcer. In an earlier paper, Dinsmoor and Clayton (1963) had pointed out that to obtain sufficiently large and sufficiently long-continued effects of reinforcing stimuli, for convenient study, it seems to be necessary in most cases to maintain the effectiveness of the secondary reinforcer by continued association with the primary reinforcer. Furthermore, a number of writers have suggested that in the appetitive case, at least, "in order to act as a S^r (Secondary Reinforcer) for any response, a stimulus must have status as an S^D (Discriminative Stimulus) for some response" (Keller & Schoenfeld, 1950, p. 236). These considerations led them to examine the operation of secondary reinforcement within an intact chain of behavior, in which one response produces and is maintained by the discriminative stimulus for another response.

Furthermore, Kelleher and Fry have forwarded that a comparison of performances on a tand Fl Fl Fl and chain Fl Fl Fl indicates that each of the component stimuli in the chained schedule is a discriminative stimulus; that is, different response rates and response patterns occur in each of the component stimuli. In a 1962 publication, they realized that in the first

component of a chained schedule, prolonged pauses developed. This made them observe that, neither the rate nor pattern of responding in the first component indicated that the appearance of the second-component stimulus is a conditioned reinforcer. But in the second component of the chained schedule, response rates were lower than in the second component of the tandem schedule; however, the positively accelerated responding, which is a characteristic of simple Fl schedules of food reinforcement, indicated that the appearance of the third-component stimulus was a conditioned reinforcer (Kelleher & Fry, 1962).

A conclusion that can be formulated from their observation and one which they arrived at was that, a comparison of performances on tand Fl Fl Fl and variable chain Fl Fl Fl indicates that each of the component stimuli in the variable chained schedule also becomes a discriminative stimulus controlling a specific response rate and pattern of responding.

They continue to explain that, although each component stimulus of the variable chain becomes a discriminative stimulus for positively accelerated responding, no stimulus is in the unfavorable position of consistently following reinforcement. Again, each component stimulus of the variable chain tends to be associated with food delivery in one out of three sequences, thus on the average this intermittent association might maintain each stimulus as a conditioned reinforcer.

The case of the discrimination design so far has if not flawlessly held strong, and as Skinner (1938) had already pointed out "it is now quite certain that if a stimulus is to become a secondary reinforcer it must become a "*discriminative* stimulus" (Keller, 1954. p. 58). But Kelleher and Gollub (1962) later counted this; forwarding that although discriminative stimuli are usually conditioned reinforcers, the available evidence indicates that establishing a stimulus as a discriminative stimulus is not necessary or sufficient for establishing it as a conditioned reinforcer. Discriminative stimuli in chained schedules with several components are not always conditioned reinforcers; stimuli that are simply paired with reinforcers can

become conditioned reinforcers; concluding that the hypotheses that have been offered as alternatives to the concept of conditioned reinforcement are too limited to integrate the data that exist. So far both designs have shown that they can yield conditioned reinforcers but not as to which one is the most effective this then calls for further studies

Problems Presented by Pairing Designs:

This section will present in a brief point by point structure some reported problems associated with paired designs of conditioned reinforcers.

Birnbrauer (1971) expressed some problems associated with conditioning using a pairing design. He points out that pairing a neutral stimulus and reinforcement changed the function of the previously neutral stimuli in other components of the multiple schedule; the data are compatible with the conclusion that the words became conditioned reinforcers. However, in the face of this acknowledgement, three troublesome aspects of the results appeared. First, in a paired instance, in the absence of discrimination success of conditioning is marginal. Birnbrauer (1971) explain that responding in both test components increased and decreased together; the explanation is that pairing effected a change in the function of a class of stimuli, such as words or auditory stimuli, or that the participants failed to discriminate the two words despite their distinctiveness to the experimenter. Secondly, in paired designs, as Birnbrauer (1971) points out, presents a situation where important uncontrolled variables tend to influence the experimental results, the effect is that even if conditioning does occur, the effect of the conditioned reinforcer is either short lived or of low value to the responder.

Thirdly, in pairing procedures, perceived strength of conditioned reinforcers appears to be due to presentations of the primary reinforcement component, which were controlled by the duration and number of reinforcements presentations rather than the reinforcement value of the primary reinforcer or experimental design.

On the basis of these problems, Thomas (1969) and Birnbrauer (1971) observed that Behavior producing the stimulus sometimes declined despite the fact that the stimulus was being paired with primary reinforcement. (b) The effects were difficult to reproduce after recovering Baseline performance, and (c) The function of the paired stimulus was not affected when it was dispensed in a component separated from access to primary reinforcement. Thomas apparently did not obtain (a) or (b). With regard to (c), he reported that interpolation of a 5-min blackout between the primary and conditioned reinforcement components had no effect upon responding in the latter (Birnbrauer, 1971; p.362)

Gollub in discussing experimental procedures involving Brief Stimulus Presentations; that is stimuli paired with primary reinforcement, explain that such procedures have frequently involved second-order schedules of reinforcement. He however points out that under second order schedules; the behavior on which reinforcement depends is itself subject to reinforcement schedule.

Stubbs (1971) recognized the problems involved in the usage of pairing using brief stimulus presentations. He wrote that on the basis of reported studies, in which comparisons have been made, the results have suggested that pairing of a brief stimulus with food produces different effects compared to non-paired stimulus yet his finding was that no difference existed in response frequency between the effects of a paired and non-paired stimulus over the range of schedules studied. The results suggest that pairing then, is not necessary for a brief stimulus to affect performance at least under certain schedules. The argument that pairing operations are necessarily more effective than non-pairing in maintaining second-order schedule performance then is not valid. It is possible, however, that in some circumstances pairing operations might produce greater effects on second-order schedule performance; not all possibilities have been eliminated.

It is true so far that paired instances have resulted (when they have succeeded) in weak conditioned reinforcement; and even in such situations there appears to be confounding explanations to what actually happened in the experiment, but in the case of verbal behavior, it has failed to chalk any successes at all. The way forward then seems to be designs based on discriminative trials.

A Conclusion

The discrimination of stimuli to a large extent draws inference from attending to a presenting stimulus and its ensuing control over the emitting of a desired response. Aptly stated by James, (1890), "e*veryone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness is of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state which in French is called distraction and zerstreutheit in German*". Thus, as Catania (1994) has put it; to discriminatively respond on the basis of some stimuli or stimulus property, an organism must be said to be *attending to* a stimulus or stimulus property, when variation of that stimulus or stimulus property changes behavior. For regardless of the selection history of the behaving organism, a stimulus must be sensed if it is to guide behavior.

It would be a mistake, however, to regard the individual as simply a passive recipient of what ever the physical energies happen to fall on his receptors. The individual through his own behavior profoundly and extensively influence the environmental events they sense. This places the responses of this category in a context whereby they become the joint products of ancestral and individual environments (Donahoe & Palmer 2004).

A persistent research problem in conditioned reinforcers has been the establishment of a strong durable conditioned reinforcing effect in the laboratory (cf. Kelleher, 1966a; Kelleher & Gollub, 1962; Kimble, 1961; Meyers, 1958; Miller, 1951; Wike, 1966; 1969). "In reaching our goal [of understanding human behavior] the principle of secondary reinforcement will be of great analytical assistance. . . . It gives a powerful and indispensable tool for the solution of many vexing and absorbing problems of human action" (Keller & Schoenfeld, 1950, p. 260). Although it is characteristic of human behavior that primary reinforcers may be effective after a long delay, this is presumably only because intervening events become conditioned reinforcers. (Skinner, 1953, p. 76) There is probably no concept in all of psychology that is in such a state of theoretical disarray as the concept of secondary reinforcement (Bolles, 1967).

As explained by B. F. Skinner in his paper *Contrived Reinforcement;* there is nothing new about the modification of behavior. Teachers have always modified the behavior of their students and students the behavior of teachers. Employers have always modified the behavior of employees and employees the behavior of their employers. Therapists modify the behavior of those they help and those who are helped the behavior of their therapists. Governors modify the behavior of the governed and the governed the behavior of the governors. Parents modify the behavior of their children and children the behavior of their parents. As friends, lovers, and acquaintances we modify the behavior of each other. The only thing that is new is a better understanding of how we do so, derived from the experimental analysis of behavior.

Catania et al. (1974) have pointed out that stimulus control studies show an organism's tendency to respond as a function of some property of a stimulus. The effectiveness of a stimulus in serving as a reinforcer, therefore, depends on the stimulus property that varies, the history of contingencies in the presence of different values of the stimulus property, and the

conditions under which the its reinforcing values are conditioned and determined (e.g., Hearst, Besley, & Fartlhing, 1970; Terrace, 1966).

The literature so far has presented experimental designs used in the conditioning of secondary reinforcers. There are some pertinent issues that still need addressing in relation to these designs. Squires et al. (1975) summarised the three types of second-order schedules that are commonly used: tandem, brief-stimulus, and chain schedules. They point out that on a tandem schedule, the same exteroceptive stimulus is present throughout the interreinforcement interval; whilst on brief-stimulus schedules, appears the same as a tandem schedule, except that completion of each component is signaled by the brief presentation of a second stimulus. On a chain schedule, each component is associated with a different stimulus (frequently, different key colors). The use of second-order schedules in the analysis of various stimulus functions (e.g., discriminative and/or reinforcing) has been thoroughly reviewed by Kelleher (1966) and Kelleher and Gollub (1962). An important difference between the behavior maintained by these three procedures is that on an extended chain schedule (more than two component schedules), response rates in the initial components are usually depressed compared to those maintained by a comparable tandem schedule (Fantino, 1969; Gollub, 1958; Jwaideh, 1973; Kelleher & Fry, 1962), or by a comparable brief-stimulus schedule (see Stubbs, 1971). Squires and her colleagues have explained their observed differences in the methods; in terms of the conditioned reinforcing properties of the stimuli. In principle then, neutral stimuli subjected to these methods become effective conditioned reinforcers.

Irrespective of the success presented by experimenters, some doubt has been cast upon this explanation by Stubbs' (1971) finding that brief stimuli also facilitate responding when presented at the end of each component, except the one preceding primary reinforcement. These "unpaired" brief stimuli are presumably not conditioned reinforcers because of the temporal distance between then and the primary reinforcer; consequently, their effectiveness

in enhancing response rates weakens the conditioned reinforcement explanation outlined above. An alternative explanation of the difference in the effects of tandem, chain, and brief-stimulus schedules can be made in terms of what the animal learns when exposed to these schedules. There is considerable evidence from classical conditioning studies that the emission of a conditioned response is dependent on the context in which the conditioning occurs, and is not always a simple function of the relation between the conditioned and unconditioned stimuli (Dawson, 1970; Dawson & Grings, 1968; Grings, 1965; Grings & Lockhart, 1963). In a similar way, the relationship between responding and reinforcement on second-order schedules may not be the only determinant of response rate. Instead, the different stimulus conditions associated with these second-order schedules may result in the animal attending to different aspects of the situation and learning a different set of relations (Squires et al., 1975).

Skinner (2005) has pointed out that; in Pavlovian experiment, however, a reinforcer is paired with a *stimulus;* whereas in operant behavior it is contingent upon a *response.* In Pavlovian or "respondent" conditioning we simply increase the magnitude of the response elicited by the conditioned stimulus and shorten the time which elapses between stimulus and response. We note, incidentally, that these two cases exhaust the possibilities: an organism is conditioned when a reinforcer [1] accompanies another stimulus or [2] follows upon the organism's own behavior. Any event which does neither has no effect in changing a probability of response.

In Squires et al. (1975) paper, they report two experiments in which pigeons failed to discriminate well between the components of second-order schedules of brief-stimulus presentation. He concluded that the failure to respond differentially to brief stimuli terminating the first and last components of a second-order schedule shows that pigeons not only fail to discriminate between components of second-order schedules of brief-stimulus

presentation, but that they are unable to form such a discrimination even when failure to do so prevents delivery of primary reinforcement.

Taking a look at current literature, one may observe that few pages are allocated to discussions on the concept of conditioned reinforcers. It may appear that the problem of a better conditioning design has been resolved. But then, as the literature reviewed so far has showed, be it brief-stimulus presentations or chained or tandem designs, the explanatory paradigms and testing mechanisms for conditioned reinforcers remains at best only breached the issue of identifying a lasting and effective design for establishing conditioned reinforcers. Williams (1994) commenting on this case, writes that in recent textbooks on learning, the perception of conditioned reinforcements importance has receded substantially. In contrast to the typical chapter-length treatment of the topic in learning texts of a generation ago (e.g., Kimble, 1961; for an entire book devoted to the topic, see Wike, 1966), it now receives cursory treatment, often consisting of no more than a definition and a few examples of its application. In cases where researchers have failed to realize conditioned reinforcement effects in their "*neutral stimuli*" they have attributed the fault to other confounding variables rather than the design. The effectiveness of conditioned reinforcers has long been known to derive from the designs that establish them; thus faulty or weak designs will mean weak reinforcers. What holds now is that the Pavlovian or pairing related designs have failed to present strong and effective conditioned reinforcers. They do tend to weaken very fast and do not generalize very well. There appears to be a need then to dive into the stormy waters of conditioned reinforcers with the hope of exposing more of its secrets; if not find the best or better design for conditioning reinforcers. This case is best presented by two reports of Williams (1994) and Lovaas et al. (1966).

The importance of conditioned reinforcers have long been realized both experimental and applied analysis of behavior. Bijou and Baer, (1961), Ferster (1961), Rimland (1964), and

Betz (1947) have all explained autism in terms of a failure to acquire social responses on the basis of a failure to attend be affected to social stimuli. For instance, Ferster (1961), as presented by Lovaas et al. (1966), argued within the reinforcement theory, hypothesizing that the social environment has no secondary reinforcing function for the autistic child; hence the child fails to develop the appropriate behaviors. The same Lovaas et all article also presents an argument by Betz (1947) who regarded autism as the establishment of a rather impermeable interpersonal barrier, which shuts off social stimuli.

Considering such analytical definitions of autism; which appears to permeate most definitions of behavioral deficiencies and problems; (e.g. Iwata's analysis of self injurious behavior), conditioned reinforcers do tend to play a key role in the idea of behavioral change that is propounded by most applied behavior analysts. Thus, as aptly argued by Lovaas et al (1966), if one worked within a reinforcement theory paradigm, one could facilitate the behavioral development of autistic children in two ways. One could circumvent the use of social stimuli altogether, and build behaviors by relying on primary ("biological") rewards, such as food. At present, there is ample evidence to demonstrate that autistic children will acquire new behaviors when primary reinforcement is used. The use of primary reinforcement has an obvious disadvantage, in that special environments need to be established to develop and maintain the new behaviors. Since we have inadequate information about how to construct such environments, the results of therapeutic efforts would probably fall short of the ideal. A second alternative would be to concentrate treatment efforts on facilitating the autistic child's acquisition of social reinforcers, rather than directly on building behaviors. A treatment program centered on the establishment of a normal hierarchy of social reinforcers would give the child's every-day social environment (his parents, teachers, peers, etc.) the tools with which to build and modify the myriad behaviors necessary for the child to function effectively within that environment (Lovaas et al., 1966).

Thus having been clearly explained that existing known methods for establishing seemingly neutral stimuli as reinforcers through experimental designs have at best been partially successful (in the case of paired relations), and that the idea of discriminative learning has at best been a last resort, it would be pragmatic for current behavioral studies to refocus on the design elements necessary for establishing effective, durable and flexible conditioned reinforcers

References

Atkinson, R. L., Smith, E. E., and Hilgard, E. R. (1987). *Introduction to Psychology (9th ed.).* New York: Harcourt Brace Jovanovich, Inc.

Betz, *B. (1947).* A Study of tactics for resolving the autistic barrier in the psychotherapy of the schizophrenic personality. *American Journal of Psychiatry, 104: 267-273*

Bijou. *S. W.*, and Baer, D. M. (1961). *Child development: A systematic and empirical theory (vol. 1).* Englewood Cliffs, NJ: Prentice Hall.

Birnbrauer, J. S., (1971). Effects of Pairing Stimuli with reinforcement on multiple schedule performance of children. *Journal of the Experimental Analysis of Behavior, 16, 355-365*

Bolles, R. C. (1967). *Theory of motivation.* New York: Harper & Row.

Bower G H & Hilgard E R. (1981). *Theories of learning.* Englewood Cliffs, NJ: Prentice-Hall.

Carlson, N.R. (1993). *Psychology: The Science of Behavior, fourth edition.* Boston: Allyn and Bacon.

Catania, A. C. (1992). *Learning (3rd ed.*). Englewood Cliffs, NJ: Prentice Hall.

Catania, A. C. (2007). *Learning. (4th Interim ed.)* New York: Sloan Publishing.

Catania, A. C. (1979). *Learning.* Englewood Cliffs, NJ: Prentice-Hall.

Catania, A. C., Silverman, P. J., & Stubbs, D. A. (1974). Concurrent performances: Stimulus-control gradients during signaled and unsignalled schedules of concurrent reinforcement. *Journal of the Experimental Analysis of Behavior, **21**, 99-107*

Catania, A. C. (1966). Concurrent operants. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application (pp. 213-270).* New York: Appleton-Century-Crofts.

Catania, A. C. (1994). The natural and artificial selection of verbal behavior. In Hayes, S. C., Hayes, L. J., Sato, M., & Ono, K. (Eds.) *Behavior analysis of language and cognition (pp. 31-49).* Reno, NV: Context Press.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior Analysis.* Merrill Publications: Columbus.

Cooper, J. O., Heron, T. E., & Heward, W. L. (1997). *Applied Behavior Analysis.* Merrill Publications: Columbus.

Davol, G. H., Steinhauer, G. D., & Lee, A. (1977). The role of preliminary magazine training in acquisition of the autoshaped key peck. *Journal of the Experimental Analysis of Behavior, 28, 99-106.*

Dawson, M. E., Grings, W. W., (1968). Comparison of classical conditioning and relational learning. *Journal of Experimental Psychology, 76, 227–231.*

Dawson, M. E. (1970). Cognition and conditioning: Effects of masking the CS-UCS contingency on human GSR classical conditioning. *Journal of Experimental Psychology, 85, 389–396.*

Dinsmoor, J. A. and Clayton, M. H., (1963). Chaining and secondary reinforcement based on escape from shock. *Journal of the Experimental Analysis of Behavior, 6:75–80.*

Dinsmoor, J.A. and Clayton, M.H., (1966). A conditioned reinforcer maintained by temporal association with the termination of shock. *Journal of the Experimental Analysis of Behavior, **9**, pp. 547–552.*

Dinsmoor, J. A. (1950). A quantitative comparison of the discriminative and reinforcing functions of a stimulus. *Journal of Experimental Psychology, 40, 458-472.*

Donahoe, J. W., & Palmer, D. C. (2004). Learning and complex behavior. Boston: Allyn & Bacon.

Fantino, E., & Romanowich, P. (2007). The effects of conditioned reinforcement rate on choice: A review. *Journal of the Experimental Analysis of Behavior, 87, 409–421*

Fantino E., (1969). Conditioned Conditioned reinforcement, choice, and the psychological distance to reward. In D.P. Hendry (Ed.) *Conditioned reinforcement (pp. 163-191).* Homewood, IL: Dorsey Press.

Ferster, C. B. (1961). Positive reinforcement and behavioral deficits of autistic children. *Child Development, 23, 437-456.*

Ferster, C. B. and Skinner, B. F. (1957). *Schedules of reinforcement*. New York: Appleton-Century-Crofts.

Gollub, L. R. (1970). Information on conditioned reinforcement: A review of Conditioned Reinforcement, edited by Derek P. Hendry. *Journal of the Experimental Analysis of Behavior, 14(3): 361–372.*

Gollub, L. R. (1958). The chaining of fixed-interval schedules. Unpublished doctoral dissertation, Harvard University.

Grant, L. & Evans, A. (1994). *Principles of Behavior Analysis.* New York: Harper Collins College Publishers.

Grings, W. W. and Lockhart, R. A. (1963). Effects of "anxiety lessening" instructions and differential set development on the extinction of GSR. *Journal of experimental Psychology, 66, 292-299.*

Grings, W. W. (1965). Verbal-perceptual factors in the conditioning of autonomic responses. In W. F. Prokasy (Ed.), *Classical conditioning.* New York: Appleton-Century-Crofts, Pp. 71-89.

Hake, D. F. and *Azrin*, N. H. (1965). Conditioned punishment. *Journal of the Experimental Analysis of Behavior, 8, 279-293.*

Hearst E., Besley S. and Farthing G.W., (1970). Inhibition and the stimulus control of operant behavior. *Journal of the experimental Analysis Behavior. 14 pp. 373–409*

Per Holth (2001). The persistence of category mistakes in psychology. *Behavior and Philosophy, 29, 203-219*

Jackson, K., & Hackenberg, T. D. (1996). Token reinforcement, choice, and self-control in pigeons. *Journal of the Experimental Analysis of Behavior, **66**, 29-49.*

James, W. (1890). *The Principles of Psychology*. New York: Holt.

Jwaideh, A. R. (1973). Responding under chained and tandem fixed-ratio schedules. *Journal of the Experimental Analysis of Behavior, 19, 259–267.*

Kelleher, R. T., & Fry, W. T. (1962). Stimulus functions in chained fixed-interval schedules. *Journal of the Experimental Analysis of Behavior, 5, 167–173.*

Kelleher, R. T. and Gollub, L. R., (1962). A review of positive conditioned reinforcement. *Journal of the Experimental Analysis of Behavior, 5, 543-597.*

Kelleher, R. T., (1966a). Chaining and conditioned reinforcement. In W. K. Honig (Ed.), *Operant behavior: areas of research and application.*. New York: Appleton-Century-Crofts, Pp. 160-212.

Keller, F.S.; Schoenfeld, W.N (1950). *Principles of psychology*. New York: Appleton-Century-Crofts.

Keller, F.S. *(*1954*). Learning: Reinforcement Theory.* NY: Random House.

Kimble, G. A., (1961). *Hilgard and Marquis' Conditioning and learning*. New York: Appleton-Century-Crofts.

Nelson Mandela (1995). *Long Walk to Freedom: The Autobiography of Nelson Mandela;* Little Brown & Co

Lovaas, O. I., Freitag, G., Kinder, M. I., Rubenstein, B. D., Schaeffer, B., and Simmons, J. Q. (1966). Establishment of social reinforcers in two schizophrenic children on the basis of food. *Journal of Experimental Child Psychology, 4, 109-125.*

Marr, M. J. (1969). *Second-order schedules. In D. P. Hendry (Ed.), Conditioned reinforcement*. Homewood, Ill.: The Dorsey Press. Pp. 37-60.

Martin, *G. L., &* Pear, *J. J. (*1996*). Behavior modification: What it is and how to do it (6th ed.).* Upper Saddle River, NJ: Prentice Hall

Meyers, J. L. (1958). *Secondary reinforcement: a review of recent experimentation.* Psychological Bulletin, 55, 284-301.

Miller, N. E. (1951). Learnable drives and rewards. In S. S. Stevens (Ed.), *Handbook of experimental psychology*. New York: John Wiley. Pp. 435-472.

Myers, J. L. and Myers, N. A. (1964). Secondary reinforcement in children as a function of conditioning associations and extinction percentages. *Journal of Experimental Psychology, 68, 611-612.*

Myers, J. L. and Myers, N. A. (1965). A test of a discrimination hypothesis of secondary reinforcement. *Journal of Experimental Psychology, 70, 98-101.*

Myers, J. L. and Myers, N. A. (1966). Secondary reinforcement in children as a function of training procedures. *Journal of Experimental Psychology, 72, 627-628.*

Myers, J. L. (1958). Secondary reinforcement: a review of recent experimentation. *Psychological Bulletin, 55, 284-301.*

Neuringer, A. J. and Chung, S. H., (1967). Quasi-reinforcement: control of responding by a percentage-reinforcement schedule. *Journal of the Experimental Analysis of Behavior, 10, 45-54.*

Nunnally, J. C., Duchnowski, A. J., and Parker, R. K. (1965). Association of neutral objects with rewards: effect on verbal evaluation, reward expectancy and selective attention. *Journal of Personality and Social Psychology, 1, 270-274.*

O'Donohue, W. (1998). Conditioning and third generation behavior therapy. In W. O'Donohue (Ed.) *Learning and behavior therapy.* Boston: Allyn & Bacon.

Pierce, W. D., & Cheney, C. D. (2004). *Behavior analysis and learning (3rd ed.).* Mahwah, NJ: Erlbaum.

Pryor K. (1984). *Don't shoot the dog: The new art of teaching and training. (Rev. ed.).* New York: Bantam Books.

Rimland, B. (1964). *Infantile autism.* New York: Appleton-Century-Crofts.

Ryle, G., (1949). *The Concept of Mind.* Chicago: The University of Chicago Press

W. N., Antonitis, J. J., and Bersh, P. J. (1950). Unconditional response rate of the white rat in a bar-pressing apparatus. *Journal Comp. Physiol. Psychol. 43, 41-48*

Sheafor Bradford W. and Horejsi Charles R. (2005). Techniques and Guidelines For Social Work Practice. Allyn & Bacon

Skinner, B. F. (1953). *Science and human behavior*. New York: Macmillan.

Skinner B. F. (2005). *Science and Human Behavior.* Pearson Education, Inc.

Skinner, B. F. (1938). *The behavior of organisms.* New York: Appleton-Century-Crofts.

Skinner, B. F. (1948). "Superstition" in the pigeon. *Journal of Experimental Psychology, 38, 168-172.*

Skinner, B. F. (1953). *Science and human behavior.* New York: Macmillan.

Squires, N., Norborg, J., & Fantino, E. (1975). Second order schedules: Discrimination of components. *Journal of the Experimental Analysis of Behavior, 24, 157–171.*

Stubbs, A. D. (1971). Second-order schedules and the problem of conditioned reinforcement. *Journal of the Experimental Analysis of Behavior, 14, 289–313.*

Terrace, H. S. (1966). Stimulus control. In W. K. Honig (Ed.) *Operant behavior: areas of research and application.* New York: Appleton-Century-Crofts. Pp. 271- 344.

Thomas DR (1969) The use of operant conditioning techniques to investigate perceptual processes in animals. In: Gilbert RM, Sutherland NS (eds) *Animal discrimination learning.* Academic, London

Thorndike, E. L. (1905). *Elements of psychology.* New York: A. G. Seiler.

Toseland, *R. W., &* Rivas, *R. F. (*1995*). An introduction to group work practice (2nd ed.).* Boston: Allyn and Bacon

Wike, E L. (1966) (Ed.), *Secondary reinforcement: selected experiments.* New York: Harper and Row.

Wike, E. L. (1969). Secondary reinforcement: some research and theoretical issues. In W. J. Arnold and D. Levine (Eds.), Nebraska symposium on motivation. Lincoln, Nebraska: University of Nebraska Press. Pp. 39-82.

Williams, B. A. (1994). Conditioned reinforcement: Experimental and theoretical issues. *The Behavior Analyst, 17, 261–285.*

Wilson E. O. (1998) *Consilience: The Unity of Knowledge with On Human Nature*. New York: Knopf, April.

Zimmerman, D. W. (1960). Intermittent reinforcement of discriminatively controlled responses and runs of responses. *Journal of the Experimental Analysis of Behavior, 3, 83-91.*

COMPARING THE EFFECTIVENESS OF TWO PROCEDURES FOR THE ESTABLISHMENT OF CONDITIONED REINFORCERS

Abstract

The search for a procedure for experimentally establishing conditioned reinforcers effectively and with lasting results was shelved by experimental behaviour analysts. However, recent studies resulted in more questions of what we thought we already knew about conditioned reinforcers. This research sought to retest the basic and previously accepted procedures for establishing conditioned reinforcers. These procedures are the operant or discriminative learning and brief pairing of stimuli. Two studies were conducted, one involving two participants and the other only one. Experiment 1 tested the effectiveness of established conditioned reinforcers with a temporal time between post tests of each procedure. Experiment 2 tested for effectiveness and value of established conditioned reinforcers in a choice situation. The results overwhelmingly presented results indicating that in order to establish conditioned reinforcers, the best suggestible procedure would be ones based on the operant learning paradigm.

Key words: *Briefly paired stimuli, Conditioned Reinforcers, Operant Discrimination, Tokens*

A closer look at the published papers in the Journal of Applied Behaviour Analysis and Journal of Experimental Analysis of Behaviour shows that over the past decade, there has not been a single issue without a paper on reinforcement. Despite this frequency of publication concerned with reinforcement, hardly do the basic concepts of establishing neutral stimuli as reinforcers come to light. A reason for this might be related to its roots in Pavlovian conditioning, but this method is not the only method of conditioning neutral stimuli to become reinforcers. Discriminative contingencies have also been found to establish conditioned reinforcers. My point was aptly put by Myers (1958). He stated that in

> "the past decade, psychology has witnessed two important research trends in the area of secondary reinforcement. Whereas the bulk of previous research was concerned with demonstrating the existence of secondary reinforcement, recent experimentation has centred about the question of defining secondary reinforcement and, in particular, exploring alternative explanations of the data and the investigation of parameters which effect various measures of secondary reinforcement. Some experimenters have been concerned with differentiating between the role of the original neutral stimulus as a cue and as a reinforcer. Others have been interested in testing the applicability of a discrimination hypothesis. Much experimentation has dealt with the effects of such variables as drive, frequency of pairing of the neutral and primary reinforcing stimuli, reinforcement schedules, and amount of reinforcement" (Myers, 1958, p 284).

Sparse information that was available prior to the 1960's made it difficult to confidently assert that discrimination training was or was not a necessary requirement for establishing a secondary reinforcer. Kelleher and Gollub (1962) amongst others conducted a lot of extensive research put this issue to rest. However, even if conditioned reinforcers can be established by different procedures, it would be important to know whether some procedures are more efficient than others in establishing new stimuli as conditioned reinforcers; especially when the secondary reinforcer is defined in terms of learning a new response rather than in terms of resistance to extinction.

In 1966, Lovaas and colleagues, based on Dinsmoor's (1950) Discrimination Hypothesis, ran an experiment that sought to test this hypothesis. The logical influence for

their study was, as they stated, if one worked within a reinforcement theory paradigm, one could facilitate the behavioural development of children with autism in two ways. First one could circumvent the use of social stimuli altogether, and build behaviours by relying on primary ("biological") rewards, such as food. At present, there is ample evidence to demonstrate that children with autism will acquire new behaviours when primary reinforcement is used. However, the use of primary reinforcement has an obvious disadvantage, in that special environments need to be established to develop and maintain the new behaviours. Since we have inadequate information about how to construct such environments, the results of therapeutic efforts would probably fall short of the ideal. Lovaas et al., suggested ways to circumvent this problem especially when working with persons with autism, for instance by concentrating treatment efforts on facilitating the child's acquisition of social reinforcers, rather than on building behaviours. A treatment program centred on the establishment of a normal hierarchy (Lovaas et al., 1966)

In view of presenting evidence, they found it necessary to establish whether autistic children could acquire social reinforcers (secondary reinforcement). Their logic for social settings and interactions becoming conditioned as reinforcers was that it was possible in two ways, the first was by association to an already established reinforcer (a primary reinforcer), or the removal of a primary negative reinforcer. Previous data from Lovaas et al. were cited as an empirical demonstration that social stimuli can acquire positive reinforcing properties for the behaviour of children with autism by being associated with pain reduction (Lovaas. O. I., Freitag, G., Gold, V. J., and Kassorla, I. C.; as cited in Lovaas et al., 1966)

Their explanation for this was that an autistic child will seek the presence of someone associated with his attainment of basic gratifications; who has given him pleasure, so to speak.

Though there has been extensive research on the different procedures of establishing new stimuli as reinforcers, these procedures have not been compared in an empirical study to see which is more efficient; except maybe in the Lovaas et al. (1966) paper where after a failed paired design resorted to a discriminative design to achieve success. This has led some authorities to argue that, if discrimination training is necessary, it is still not clear whether the originally neutral stimulus must retain its discriminative properties during the test session if it is to serve as a secondary reinforcer. Some research results have suggested a negative answer to this (Kelleher & Gollub 1962), but the results also failed to provide conclusive evidence. Thus, more experiments utilizing measures of goal approaching behaviour, such as number *and* latency of responses, are being called for (Myers, 1958; Ratner, 1956; Schoenfeld et al., 1950). Finally, as Myers (1958) suggested, based on Wyckoff et al.'s (1958) results the possibility should be considered that the apparent role of discrimination training in establishing secondary reinforcers is, at least in part, a function of the apparatus design. This will also require further experimental verification. In Wyckoff et al.'s paper, two experiments were reported in which rats were first trained to approach and lick a water dipper in response to the sound of a buzzer. This training was followed by a secondary-reinforcement test in which lever-pressing produced the buzzer but no water. In both cases control Ss received identical initial training, but during the final test they received the buzzer when they had failed to press the lever. Reported results indicated that there was no indication of secondary reinforcing effects shown in either of the experiments.

Lovaas et al.'s (1966) experimental report helped to enlighten researchers on the issue but for reasons unknown, though its results demanded a follow up study, there is no documentation of it having been done. In their research, they sought to establish whether social stimuli can be established as reinforcers for the behaviour of children with autism.

Suggesting that it is possible to conceive of social stimuli acquiring reinforcing powers in two ways: by association with the presentation of a primary positive reinforcer, or by the removal of a primary negative reinforcer. Data (Lovaas et al., 1966) already demonstrated that social stimuli can acquire positive reinforcing power for the child with autism by being associated with pain reduction. Their 1966 report of their research paired the word "good" with food delivery, but on testing for acquired properties of reinforcement of the word "good", the results were negative. But then this result was reported to have been anticipated, given that as babies, autistic children received all the social stimulation or reinforcement from their caregivers that most normal children received, but still refused to behave socially to attain social reinforcement. The second reason for their anticipation was based on the literature of classical conditioning. Citing Maltzman and Raskin (1965), who points out that unless the organism attends to social stimuli to a large degree, it ceases to be reinforcing enough to ensure the emitting of responses in its presence or as a means of attaining it. They further cited Bernal's (1965) experimental report where his participants failed to attend to the presenting stimuli, stating his conclusion that "… if a child cannot selectively attend to, or orient toward a stimulus, the pairing of a biologically important event with the stimulus will not result in its taking on reinforcing properties" (p. 1)

Based on this, they designed a procedure which ensured that a social stimulus would acquire reinforcing properties. The procedure involved initial training in which the child was "forced" to respond (attend) to the social stimulus. Their procedure was consistent with Dinsmoor's (1950) hypothesis which stated that a stimulus will take on reinforcing properties, in so far as subjects can discriminate that stimulus, as a necessary concomitant of reinforcement or non-reinforcement. The works of Zimmerman, (1959), was the main basis for demonstrating that their stimulus had acquired reinforcing properties. Thus, intermittent

reinforcement schedules were used in establishing a neutral stimulus as a discriminative for food and in the delivery of that stimulus as a secondary reinforcer upon new behaviour.

The main purpose of the present study was to compare the two basic designs for establishing a conditioned reinforcer. Different neutral stimuli would thus be established as reinforcers through discrimination and pairing designs within the same subjects. Considering that it is difficult to predict the number of trials required to establish a conditioned reinforcer, using on a discriminative (S^D) procedure, discrimination learning will be established and before the brief stimuli paired design will be implemented. The neutral stimulus will then be delivered contingent on new responses to test their effectiveness in evoking the target response.

One experimental question, then, is that if brief stimulus presentation procedures are equalised; same number of trials, primary reinforcers and session durations; to discriminative learning procedures, would the paired stimulus yield the same reinforcement strength and effect on a previously determined not-automatically reinforced response? Another question that seeks to be answered by the current study is whether discriminatively established reinforcers have a lasting effect compared to a pairing-established reinforcer? Finally, would conditioned reinforcers established through pairing designs hold up in a choice situation to a discriminatively established reinforcer?

The answers to these questions will throw more light on the concept of conditioned reinforcement with a focus on procedure elements and will help establish which procedure is more effective in establishing lasting conditioned reinforcers.

METHOD

Subjects

Two young children, Kofi and Ama (not their real names), participated in the current study. The biographical data were obtained by interviewing their trainers, since each child was in one way or the other engaged in a behavioral learning program.

Kofi was an 11-year-old boy with a developmental age of about 4 years at the time of the experiment, had been diagnosed with autism and had undergone some form of behavioral training programs aimed at improving his social interaction. However, he still exhibited some stereotyped responses, one of them being the tendency to spit. His verbal repertoire was well established such that he could vocally mand for help and items and also participates in a considerable conversation with another person. His training history was determined (through consultations with his caregiver and therapists) not to confound the experimental results if care was taken to choose arbitrary responses for both testing and conditioning stages of the experiment.

Ama was a girl of about 12 years of age and about 7 years developmentally. She was a unique participant in that she had not yet been diagnosed for any behavioral deficit; yet it was clear that she had a developmental deficiency. However, she displayed behavioral patterns similar to a person with ADHD. The main problem perceived to occur with Ama was getting her to attend to the presented stimuli. She had only recently been introduced to a behavioral training program, but she possessed a well established verbal repertoire and could carry on very well in a conversation of simple words and sentences.

Prior to and during the experiment, all the participants were engaged in various behavioral programs which were non-related to the current study.

Apparatus

Record

The experiment was recorded with the help of two cameras, a Sony camcorder with a lens of about 10megapixels (sited on a camera tripod) and an inbuilt laptop camera of about 1.3megapixels (HP Pavilion dv6000). They were both situated on opposite sides of the room and their positions never changed throughout the experiment. In order not to distract the participants (especially Ama), the screen of the laptop was covered with 2-sheet thick A4 white paper held together by a plain cellophane tape. Behavioral Score Sheets approved by the Norwegian Association of Behavior Analysis was used to score the responses continuously; recording on a failed, correct or prompt code structure (Table 1 depicts a plain score sheet). A pencil or blue inked pen was used to score the sheets. Cumulative graphs were obtained using Norton's (1988) cumulative scoring program.

Reinforcer Deliverer

A small plastic bowl served as the delivering container for reinforcers (UC). This was a bowl of about 4inches in length and 2inches in width but about 6inches deep. Tiny plastic cereal bowls served as containers for the edible reinforcers and a plastic basket served as the container for the play items serving as reinforcers. the cereal bowls were of the primary colors and their coloration did not appear to interact with the participants throughout the study (these bowls were available in the behavioral lab's kitchen which served as dining room for the participants during the experiment and they were never seen interacting with them at any moment in time nor were they used to serve them food.

Furniture

The chairs were adult sized classroom styled chairs with high backs (used by the experimenter and her assistants) whilst the participant was seated on a fourth chair, about 2 ft above the ground. One table was about 2 ft high and a surface area of about 1 m^2 and was

used for presenting materials during the experiment. A second table served as a platform for the laptop camera, and trolley was used to hold reinforcers and experimental tools. The Trolley was always placed next to the experimenter and never within reach of the participants.

Other

The experimental room was about 11 m^2 in size and aside the above explained items, had a television (TV) set situated at least 2 m above the ground on a platform fixed to the wall and facing the door to the room; the TV was never in use during or in between sessions. The room was illuminated by two florescent tubes of about 40 watts each, was partially sound proof and had an observational window which was not a see through when one was in the room. The room was devoid of any play items.

Procedure

Both participants were subjected to basically the same experimental design. On the assumption that in discriminative learning it is possible to observe when the S^D starts to function as such, whereas during the pairing procedure, there is no similar basis for observing that a new stimulus function is established, the same number of trials was ran in both procedures both participants were first exposed to discriminative learning before the brief stimulus pairings.

Testing Phase:

Selection and test for preference for primary reinforcers

In consultation with the trainers of the participants, a number of primary reinforcers were chosen, but this number exceeded the number that was required by the experiment (4 appetitive and 4 play items). Thus a test of preference was conducted to find out which stimuli were preferred and in what order. This test was necessary, since in working with autistic children who tend to exhibit “design stress” one needs to monitor their interest from

time to time, especially when this happens during a session. Tables 1 and 2 show the order in which Kofi and Ama chose the reinforcers that were hand picked by their trainers.

Insert Tables 1a, 1b; 2a, 2b; here

On the basis of the above preferences, toys and edible items which fell within the range of 1 to 4 were selected, and the 5th to be selected was kept on standby in case of satiation with any of the other reinforcers.

For the selection tests, the items were arranged on a table such that each was equidistant from where the participant was sitting and were already on the table prior to the participant being introduced into the room. About ten seconds was allowed to settle the participant into the room; settling down was after the child was seated at the table; after which the experimenter picked each item one at a time and gave it to the participant. In the case of edibles, they were placed in the participants hand from whence he or she placed the stimulus in his or her mouth independently. This method was adopted because the play items would also be presented the same way. Kofi attended to the experimenter 70%, and Ama, 50% of the time during this initial session. After the manual prompts from the experimenter, there was as pause for about 3 min during which the participants were led out of the experimental room; and the items rearranged. The same 10 sec of settling down time was allowed; after which the experimenter issued the command "*vær så god*"; Norwegian for "help yourself". The response to this command was already in the repertoire of both participants as signaling permission to engage in a response. The experimenter employed the ignore condition of Iwata et al. (2000), until a choice was made. After a choice was made, in order not to be selected twice, the selected item was removed from the table. This was done till all the items were selected (except in instances when some items were ignored totally and never selected; refer

to Table 1b). It is worth mentioning that items were arranged in the same order that they appear in the tables. There were two assistants in the room for this phase of the experiment; one was the participants' teacher and the other a neutral person (that was new to the participant). None of them interacted with the participant during experimental sessions. They served as ongoing scorers, and for this session interobserver agreement was at 98% for the edible selection sessions and 100% for the play items. Inter-Scorer Agreement (ISA) or Inter Observer Agreement (IOA) was calculated using the interval-by-interval method as described in Cooper, Heron and Heward (2007); thus the formula used was

$$\frac{\text{Number of intervals agree}}{\text{Number of intervals agreed + number of intervals disagreed}} \text{ X } 100 = \text{Interval-by-interval ISA \%}$$

Given that the numbers of trials in all the experiments were minimal, almost all the trials were used in the scoring. All in all, about 18 trials were scored for Kofi and 20 trials for Ama in the reinforcer selection sessions and about 100 trials were used in the calculations for Kofi and 80 trials for Ama from the test of reinforcer sessions to the end of the training sessions for both procedures were used in the calculations for the I OA or I SA. These trials made up about 90% of the total number of trials in the whole experiment for both participants. This formula was used throughout the experiment to test for agreement between scorers.

Test for neutral stimulus and non-automatically reinforced responses

The basic procedure for testing conditioned reinforcers is to make them contingent on target responses and on the basis of observed increase in frequency as compared to baselines a conclusion is drawn. This study was no different. The identification of a neutral stimulus has always been of great importance in experimental designs. Catania (1994) has pointed out that neutral stimuli should be viewed as stimuli that are neither appetitive nor aversive. Moreover, he cautioned that to classify stimuli into such clear cut classes is not feasible, as their definition as neutral or not is contextually determined; thus each stimulus must be evaluated

relative to others that are available and its significance to the respondent. On the issue of neutral responses, Catania forwards that the events that are consequences of behavior are unlikely to be truly neutral, for it will be unlikely that they will have no effect on behavior. He thus concluded that the term neutral responses be considered as a misnomer and also contextually defined in relation to contingent stimuli.

Based on these definitive points, seemingly neutral stimuli (arbitrary stimuli) were identified and tested for their neutrality in evoking a responding. Based on how much the particular stimulus was attended to, as well as its ability to evoke a specified response, it was categorised as being neutral or not. Again responses and stimuli for this phase of the experiment were identified with the help of the trainers of the participants.

For Kofi, a number of different responses were tested for evidence of auto-maintenance, and based on the results were chosen or discarded. Figure 3 presents evidence that after the manual prompt by the experimenter in the response of "placing yellow platform on head" (YPH) and Figure 4, "placing hand on white folded A4 paper" (HWP); there were no responses by the participant, thus indicating absence of a reinforcement contingency on these responses.

Insert Figures 3 & 4

The topographies of the responses tested were as follows (in the order of testing):

1. Fix a blue thimble on a yellow Lego platform with fixers for the chosen thimble.
2. Rub a green fuzzy doll on his cheeks. Child initially actively wanted to interact with the toy and continued to do so after prompting but refused to engage in the target response.
3. Cross over fence: Kofi was expected to pick up a yellow square of about 2X2in and cross it over a white fence (a plastic 6inch Lego toy fence). It is worth noting that

since the fence was not fixed to the table permanently, if it did fall on its side and yet the yellow object was used to move across it, it still counted as an instance of the response topography of the target response. This was tested twice because the initial test had an interobserver agreement (see Hagopian et al. 1997 for a detailed discussion) of about 60%. The second test had an agreement of 98%. The large disagreement difference was on the basis of defining the topography.

4. Rub Purple Hippo toy on cheek: Kofi interacted with the toy whilst it was on the table throughout the session, but never did engage in the target response. Neither did he allow the experimenter to prompt him in rubbing it against his cheek.
5. Place hand over white sheet: this was a normal A4 sheet, set in the center of the table equidistant from both the experimenter and Kofi. After prompting, Kofi did not engage in the response or any response that falls within the topography of the target response. He did pick up the sheet and hold it, but this did not fall within the specified response' topography.

For a test of neutral stimuli, an audio cassette (described under Ama) was used as a neutral stimulus for Kofi and also a red signal light (of temporal presentation of 3 sec). During pretests, both stimuli showed that they were neutral in the sense of not evoking a target response from Kofi. Figure 1 and 2 presents results of these tests

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Insert Figure 1 & 2

On testing for non-automatic reinforcement of response and neutrality of stimuli for Ama, the results were interesting. A detailed description of the test sessions is provided below. The first part dealt with a test for a neutral stimulus, while the second part tested whether specific arbitrary responses were automatically reinforced. A number of arbitrary stimuli were tested

and accepted or discarded. Figure 6 (a, b & c) depicts results for a test on one such stimuli (colored circle; green and red on opposite sides).

An "audio cassette case with pink paper inlay" was also tested. This was delivered contingent on Ama's hand-raising, which was prompted twice. Then she engaged in the target response once, and then not again. However, she attended to the stimuli throughout the session (see Figure 5).

A new stimulus was introduced. A white square sheet of about 2 X1-inch dimensions was used to cover a 1 X 5 inches yellow strip of paper taped to the table about 6 inches from the experimenter and at least 2 feet from Ama. The uncovering of the yellow strip of paper by moving the white one was under the manual operation of the experimenter. And this was made contingent on a new response. The child was to emit a response comprising of:

a. Lifting palms off table – touching her knees - lifting hands above her head

The response was prompted by her trainer whilst the experimenter's hand was on the stimulus operating it as described. Ama engaged in this response repeatedly and not contingent on the presence or absence of the stimuli. So the stimulus was discarded (see Figure 8 for graphical display of results of this test).

The same response topography as described in the previous paragraph was made contingent on another stimulus, a small white sheet of the same dimensions of the yellow one above and same temporal distance but on the opposite side of the table. Whereas, the first one was on the right side of the experimenter, the white one was on the left side corner of the experimenter. After prompting, she did not engage in the response as shown in Figure 7 (a & b). Thus, it was accepted as a neutral stimulus.

Insert Figure 5 – 8

A number of relatively simple responses, such as “place hand on white sheet on the table”, “pick up yellow lego platform and touch it to head”, were tested, but seemed to be easily automatically reinforced, so to make the target response a bit difficult. She was then tested on two competing responses. She engaged in both in basically the same, prompted fashion. The topography of the responses in this session was that of the third response tested for Kofi and second response for Ama; in relation to tests for automatic reinforcers (see Figure 11).

Another complex response arrangement was tried. One where a small table (which was already in the room but unused) was situated at a temporal distance of 2 feet from Ama; and she was to pick up a yellow square box on it and drop it on the experimental table, then take it back. This was discarded because it was not suitable for the current experiment and also that it showed automatic reinforcement. This might have been due to many unexplained factors; one of which could be “getting up from the chair” or escaping the experimental table.

The complexity was further increased and this time she had to engage in:

a. Cross over fence
b. Yellow Lego platform to head
c. Rub fuzzy doll on the cheek
d. Set a square transparent bowl on her tummy.

Note all the response so far had been chosen on the basis of their abstractness and perceived arbitrary relation to the participant. And in this particular session the argument is that given a diverse complexity, she should have a low responding on one of the response topographies which then could be used as the testing response for the conditioned reinforcer. On the basis of this, we realized that given a complex responding system, she did not engage in any of the responses for a prolonged time; except for the first prompted. Data shows this (Figure 12)

Thus a second complex response arrangement was presented to her.

This time she had to:

a. Pick up tow plastic puzzle pieces and separate them, then fix them together again.
b. Then pick up a toy mobile phone model (with no sound) and touch it to her ear
c. Then pick up a green sheet and tap on it with one palm twice
d. Then pick up wooden train tracks and join and separate them.

As shown in Figure 13, after prompting on these responses, only the first response was engaged in for a considerable number of times after she first completed a full response cycle; even though this was the most difficult response (the pieces were difficult to put together and disassemble).

Insert Figure 9 – 13

Experiment 1

Design

The general procedure to test for automatic reinforcement for responses involved, first, two instances of the experimenter manually hand-guiding or prompting the specified response, following which the responding object was left available on the table. The child was then given the verbal S^D, "*vær så* god" and directly after this command, all experimenters in the experimental room remained silent and ignored the participant, and no reinforcement was administered. The rate of the target response was monitored, and if there was an inter-observer agreement of approximately 95%, the response was rejected or accepted as suitable for the experiment. If, however, after the response prompt, responding ran into extinction (extinction was set at 1min without the occurrence of the target response), that particular

response was retested to find out if it had actually been extinguished with a break of 5 min; following which the participant was introduced into the room with the response-related object already on the table and the response retested for automatic reinforcement.

Responses selected in this phase served as test responses for the yet to be conditioned reinforcers. Also the extinction category; set at 1 minute since the last observed target response; applies to both the tests for automatically reinforced responses and neutral stimuli.

Discriminative training procedure:

The Operant Discriminative Procedures were the same for both participants. Kofi was the first to go through it. During the discriminative training, the previously arbitrary stimulus was delivered contingent on the response of "accessing the reinforcer" on the table. Thus, even though reinforcement was always available in the delivery container and was visible to the child, he or she could only access the presenting reinforcer if the presenting stimulus was active. The presentation of UC reinforcer was always on a specific side of the table and in a position that was clearly visible to both the experimenter and the participant. If there was a response (that is an attempt to access the reinforcers) before the operating Variable Time (VT) had elapsed then the timer was reset for that particular trial and the child had to wait till the VT in effect had elapsed before being granted access to it in the presence of the neutral S^D.

The therapist and the child entered the experimental room with the assistants already seated; with the eight previously selected unconditioned reinforcers already on the table with the therapist in possession of the stimuli yet to be established as an S^D or hidden from view of the child. With both the therapists and the participant seated, the therapists issued the command "*vær så god*" so the child could access the reinforcement on the table. An additional purpose of this procedure was to help habituate the child to the experimental room and was done only during the first session of the discriminative learning phase. All reinforcers

that were to be used during the discriminative learning sessions were always present in the room and out of reach of the participant. The schedule of presentation of the S^D was:

- gradually changed from VT 4secs; (VT^a) through
- VT 7secs; designated (VT^b) and
- VT 10secs; designated (VT^c) to
- VT15sec; designated (VT^d)

Three consecutive responses in accord with each schedule were the mastery criteria for that schedule and an occasion to move on to the next schedule. The variable time on each schedule had an increasing value per trial of a gradual nature.

The experimenter presents the neutral stimulus and immediately (with a lapse of about 2s maximum) says "*vær så god*" to the child. Timing of sessions was controlled by a research assistant who timed the beginning and ending of the VT after which the neutral stimulus was made available and, thereby, an occasion for a response to occur. Thus the timing of the VT starts at "*vær*" (that is where there is a failed response or the child tried to access the stimuli on the table before the time had elapsed) and "gi tilbake" (that is after 3 s of having interacted with the unconditioned reinforcers on the table subject to correct responding commiserative of the VT in effect). If there were two consecutive wrong responses, a prompt was administered.

The S^D procedure was run till it ended with a session of the highest VT value in effect with a minimum of 9 out of 10 consecutive correct response (ccr) with a maximum of 2 s from the S^D conditioned response; of a VT15s. ($<VT \geq 9/10$ ccr); designated VT^e

After the training trials above were completed, one session – ending after three correct consecutive responses (ccr) followed by 1-min break; (3ccr1min) was run which was

followed by another session – 3ccr followed by a 2-min break (3ccr2min) and a 1 session – 3 ccr and then end with a break for normal duration (5mins)….. (3ccr5min). This last part was to help thin out the reinforcer schedule and make the response more resistant to extinction.

Insert Table 3 here

Following the 5-mins break of the last session of the 3ccr5min a posttest was run on the discriminative learning, by testing the reinforcing effects of the "red light" on one of the previously identified not automatically reinforced responses

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Insert Figure 14, 15(a & b) and 16(a & b)

Discrimination appropriate to the discriminative procedure took totally 2 days to establish, including the posttest. The first day included trials 01 through 68 and the second day trials 69 through 109 for Kofi; 01 through 40 for Ama and the second day, trials 41through 86.

Briefly paired conditioning yoked onto an S^D procedure.

The number of sessions to be run by on the briefly paired stimuli design conditioning procedure was the same as that completed on the S^D procedure. This means that:

Total Number of sessions on briefly pairing stimuli procedure =

[Total of sessions on S^D learning] [(VT^a + VT^c + VT^b + VT^d + VT^e) + ((3ccr1min) + (3ccr2min) + (3ccr5min)]

Thus the ending for every session on the briefly paired stimuli shall be equivalent to the number of trials on the corresponding discriminative session. This was design was based

on one of the experimental questions which seeks to find which procedure is more effective in establishing previously neutral stimuli as conditioned reinforcers. The rationale is that given that two different procedures are yoked on each other, post test will show one to be more effective and since both had the same number of trials and sessions spread out, the argument for the one that shows more effect will be stronger as it being the best or most effective procedure.

In achieving the brief paired stimuli, the experimenter presented the two stimuli (Neutral Stimuli (NS) and the S^R) simultaneously; that is either together or temporally separated by a maximum of 1s. Following a completion of all trials commiserative of the S^D procedure, a 5min break was instituted followed by a post test to verify if the briefly paired stimuli had become a conditioned reinforcer. Data for the post test of the briefly paired stimuli test is graphically presented. Figure 17 shows the results for Kofi and Figure 18 for Ama.

Insert Figure 17 & 18

Results

Baseline recordings were taken of responses with varying topographies and difficulty. Each participant had a specific response to engage in for any given tests. Several stimuli were tested and discarded on the basis of observed influence on response frequency. For participant Kofi, as shown in Figure **3** and **4**, following two prompted target responses and no programmed consequences of the response, he failed to engage in the target responses for the rest of the session. The results did serve as conclusive evidence that the responses would not occur on their own, nor were they automatically reinforcing for Kofi's responses. The results then served as a baseline for comparison with the post test phase. One of the responses tested

above was used in the testing of UCS to verify their neutrality as reinforcers for Kofi. Figure **1** and **2** helps to show that even though these stimuli were delivered contingent on a response prompted in their presence, they failed to reinforce those same responses.

Ama was subjected to the same baseline procedures as Kofi. Data for Ama in the test phase shows several tests to determine the neutrality of UCS and also the presence of automatic reinforcement in several responses. Simple responses of one sequence were tested initially and each of them presented evidence for automatic reinforcement; Figure **9a &b** and **10a & b** present data for such a test. It was realised that Ama imitated virtually every prompted response in considerable period of time. Some which appeared to have run into extinction were tested at least twice to show extinction, but each time all resurfaced as shown in the **b** of Figure 9 and 10. Thus, simple responses were rejected and multiple but competing responses implemented. Figure **11** shows Ama's response pattern on multiple but competing responses. The Black line represents responding in "crossing over fence" as already described for Kofi, but this time one response was "twice over the fence". The Red line represents responding on placing a "yellow Lego platform on the head." The notion of using these already tested responses was to find out if one would thin out the other. But the results show no thinning out in any of the responses. There was, however, an observed reduction in the rate of responses given a competitive choice in them. Subsequently the complexity was increased and possible responses suitable for the experiment were discovered. Figure **13** shows responding in a complex arrangement of different responses with different topographies. Where **A** shows response frequency for responses "fix and un-fix a plastic Lego puzzle of two pieces only" (Black) and " Place toy nokia mobile phone on cheeks" (Red); whilst **B** presents results in the same session for "clap on green plastic board" (Black) and "fix and un-fix wooden train tracks of two pieces only" (Red). As shown in the graph above, only the second

response on **A** was not engaged in more than once after prompting and even though the others did have a few instances of responding on them, they did run into extinction.

Having observed the a drastic drop in response rate given responses of multiple complex and competing nature, another one was tested to confirm this finding and if it holds then such a response arrangement could be used in the post test phase to test the conditioned reinforcers. Figure **12** presents results for a test for automatic reinforcement of a complex response sequence. Multiple responses of varying topographies were prompted in a random sequence and not respective to arrangement of items on the table on the experimental table. **A** represents response frequency in "cross over fence" (Black) and "yellow Lego platform to head" (Red); whilst **B** shows results for: "rub fuzzy green turtle on cheeks" (Black) and "place colorless plastic bowl on tummy" (Red). Note most of these responses had already been tested and had been shown to be automatically reinforced, but when incorporated into complex chain of responding, they did not occur more than once after prompting. Note that even though the graphs are stacked one on the other, the responses were all in the same session and are graphed according to how the items were arranged on the table, not in the sequence in which they were engaged or prompted. The interesting thing to note here is that most of the responses placed in the complex sequences had all been observed to be automatically maintained and yet in competing sequences, they failed to be maintained. On the basis of data obtained it is safe to assume that given multiple responses with varying topographies and each competing with the other, the responses rate will either be zero or close to it, if not in all at least in three of four.

Having realized that single response topographies were not good for the current experiment, a simple but multiply sequenced response (hands up – hands on knees – palm on table) was used to test for reinforcer value in identified arbitrary stimuli. These were

i. Yellow strip (1in X 0.5in) of paper covered by a white paper and under the exposure operation of the experimenter.

ii. White strip of paper (1in X 0.5in) under the exposure operation of the experimenter.

iii. Audio Cassette case with a pink paper inlay.

Figure **8** shows results for (i) and Figures **7a** & **b** for (iii) and Figure **5** (iii) respectively all were contingent on the response described above. Figure helps to show that even though the response was not tested for being automatically reinforced, results for (ii) and (iii) were acceptable as having shown neutrality in the stimuli.

Post test was carried out shortly after one establishing procedure was completed. Thus, the posttest for S^D learning as a procedure for establishing conditioned reinforcers was carried out after the break of the last training session of that procedure following which the second establishing procedure would be effected and subsequently tested.

Figure **14** presents confirming data for Kofi on the S^D procedure that the Red Signal Light had become a conditioned reinforcer able to evoke an arbitrary response of placing a "Yellow Lego Platform or board on his head"; for reference, Figure 14 has scaled down versions of Figures 2 and 3. Given the unique nature of Ama's responding with respect to prompted responses, her post tests were expected to be challenging and so they were. They showed defiance in the response on which the conditioned reinforcer was made contingent. Initially the idea was to reject her scores and base the current study on only Kofi's results until her post test scores on the brief paired procedures were seen, following the pairing procedure. Figure **15a & b** shows results for post test of the S^D established conditioned stimuli made contingent on a response of simple topography but multiple and competing

sequences. She attended to the conditioned reinforcer throughout the post test and yet responded opposite to it. Given the nature of her response, the post test was scored by two different people and inter-scorer agreement was high; about 82%. Figure **16a & b** shows the same conditioned reinforcer being made contingent on multiple but competing responses. What is unique about the response presented in Figure 16 is that, the same responses had been tested in a pretest phase and had been observed to be engaged in at similar rates yet when the same response was made contingent on the conditioned reinforcer, the difference increased considerably. With the response with the previous higher response rate now becoming the least engaged in. The same results for Figure 15 were observed and again it was scored twice by the same scorers and there was an agreement of about 96%. The conclusion then was that the procedure had been effective in establishing the neutral stimuli as a conditioned one, but its value; given the defiant responding contingent on it, would merit further studies; for now though, it will be safer to accept that it is a conditioned reinforcer.

Post test results for the briefly paired established conditioned reinforcer were obtained for both participants. Figures **17** (Kofi) and **18** (Ama), presents graphical data for both participants respectively. Figure **17** presents evidence that there was a considerable increase in response rate for Kofi when the conditioned reinforcer was made contingent upon the target response; but this was short lived and of a low frequency compared to that of the S^D established one. Results for Ama as shown in Figure **18**, was of a similar pattern to the one observed on the S^D established reinforcer. Figure **18** shows response (Tacting of color papers; lime green and blue; with a red plastic circle) frequency on a conditioned reinforcer established through brief pairing of stimuli (Empty Pink Paper inlayed Audio cassette). Just as in the post test following the S^D procedure, the responses here were competing with each other but only one was contingent on the conditioned stimuli (Responding on the Lime Green

Paper). Note even though the Lime Green Paper was more attractive and eye catching (and was intentionally chosen) the respondent; continuously observing the conditioned reinforcer did not engage in the response upon which it was contingent as much as the one upon which it was not.

Experiment 2

Design

Participant Kofi[1] served as the participant for this experiment. The experimental variables remained unchanged with respect to Experiment 1. Experiment 2 sought to test the effectiveness of the two implemented establishing designs in experiment 1, but unlike experiment 1 which did a comparative study based on test of two separate post test session conducted separately and temporally distanced, experiment two tested effectiveness of the established reinforcers in experiment one in a choice paradigm. Thus in the post test of Experiment 2, the two established reinforcers were made contingent on two separate competing responses and tested for their effectiveness. The rationale is that in a choice situation, the most effective reinforcer will evoke more responses and will thus serve as a better analytical point in reaching a constructive conclusion concerning the effective design for establishing conditioned reinforcers. This experiment was run 3days after the post test of the brief stimulus pairing procedure in Experiment 1.

The S^D had the same stimuli (red signal light) serving as a conditioned reinforcer, with the response "place yellow lego board on head" as its corresponding post test response. The brief stimulus pairing had the "empty audio cassette case" as described in experiment 1 as its conditioned reinforcer and as made contingent on the response "palm on A4 white paper folded in half".

[1] Ama was unavailable to participate in this part of the experiment.

This experiment involved a boosting of the initial experimental procedure from Experiment 1. This boost involved reinstating the last part of the discriminative learning procedure and its corresponding brief stimulus pairing procedure. Thus the boost involved rerunning the S^D session which had the highest VT value in effect with a 9 out of 10 or 10 of 10; consecutive correct response (ccr) with a maximum of 2 sec from the S^D conditioned response; of a VT15sec. (<VT≥9/10 ccr) …… $VT^{a.}$

After the training trials above were completed, one session – ending after three correct consecutive responses (ccr) followed by a 1-min break; (3ccr1min) was run which was followed by another session – 3ccr followed by a 2-min break (3ccr2min) and a 1 session – 3 ccr and then end with a break for normal duration (5min)….. (3ccr5min).

Following the boosting, 5 minutes was allowed as break time before boosting the brief stimulus pairing procedure. This involved running the same number of trials conducted in the boosting phase of the S^D procedure. The post test was conducted after a 5 min break following the last session of the boosting of the brief stimulus pairing procedure.

Results

Response rates in experiment one on both conditioned reinforcers were remarkably different, but then post tests were temporally differentiated. After a boost of both procedures the difference (now not subject to time) was clear and conclusive. As depicted in Figure **19**, the participant preferred to respond on the S^D S^{R+} rather than the briefly paired S^{R+}. The response on the S^D was consistent with few pauses; these pauses were probably due to tiredness since the response contingent on this reinforcer required more effort compared to the response on the briefly paired S^{R+}. The session ran for a considerably period of time, with the paired conditioned reinforcer running into extinction in a short time and with a very low response rate (about 2 response per minute) where as the S^D S^{R+} did not run into extinction

and with high response rate (about 7response per minute). The session was ended before it could go into extinction since the participant had started to engage in responses interpreted by his trainer as being stress related.

General Discussion

The search for empirically supported and effective experimental designs will always be paramount to science. This study was based on two basic designs for establishing conditioned reinforcers with the hope of comparing their subsequent conditioned reinforcers based on their effect on evoking response made contingent on them. Data from one participant overwhelmingly suggested that discrimination-based procedures are more likely to result in an effective long lasting reinforcer compared to that of brief stimulus pairings. In the other participant, there was ample evidence that stimuli in contingency learning do have a lasting stimulus control and effect on the responses that they are made contingent on.

The brief stimulus pairings resulted in establishing conditioned reinforcers but their effect was short lived this might be because its reinforcing strength was not as high as that of the conditioned reinforcer. Brief stimulus paired designs have been shown to yield effective reinforcers (refer to Cohen & Branch, 1991; Cohen & Calisto, 1981) though these studies did not define the length and number of reinforcers necessary to achieve this.

Though discriminative learning designs tend to rely on schedules with variable elements compared to that of briefly paired stimuli, which tend to rely on a tandem arrangement of fixed valued schedules; it is still prudent and possible to compare results on response rates from both designs. Experiment 1 did a comparing of response rates with a time difference between the tests phases and Experiment 2 presented a test that involved a choice between engaging in two diverse responses that were topographically different and contingent on two

differently established condition reinforcers. The results of Experiment 2, indicated that time did not play a major role in the differences observed in the results of Experiment 1.

The experimental question posed by the current study can adequately be said to have been at least tentatively answered by the experiment. The first being that if one were to equate brief stimulus pairing presentations to that of discriminative learning procedure, the brief stimulus presentation procedures will become relatively shorter in length and might result in stimuli with reinforcing properties, but these properties are at best weak and short lived. Results from briefly paired post test sessions for both participants as shown in Figures 17 and 18 present evidence that, though the conditioned stimuli did achieve some reinforcing value, this value was short lived and run into extinction within a short time compared to the reinforcers established by the discrimination-based procedure as shown in Figures 14, 15 (a & b) and 16 (a &b). Thus the answer to this question would be negative and in arriving at that answer we are presented with a possibility that discriminative learning procedures do provide shorter conditioning sequences and yet result in more effective and longer lasting conditioned reinforcers. In answering the first question, the second experimental question was invariable answered also.

The third experimental question for this study was that would conditioned reinforcers established through pairing designs hold up in a choice situation to a discriminatively established reinforcer? Experiment two sought to test this solely. Two responses were made contingent on previously established conditioned reinforcers. One response used a pairing procedure and the other an operant discriminative procedure and active throughout post test session. Thus the participant had a choice of responding in one response to obtain a conditioned reinforcer but not both at the same time. Figure 19 shows response rate with both conditioned reinforcers. The results showed that given a choice of reinforcers, established

using either a briefly paired or discriminatively based study, the participant preferred to engage in the response contingent on the conditioned reinforcer established by discriminative procedures. As far as this study is concerned there has not yet been any specific study that has tested this choice relation between conditioned reinforcers using the current procedures. The study that did come close to such a study was conducted by Lovaas et al. (1966), but in that study attention to operant discriminative training was only after pairing procedures had failed to establish conditioned reinforcers of verbal stimuli. Lovaas and colleagues however did report success using operant discrimination after a failure using pairing procedures. The current results overwhelmingly presented evidence that given a choice situation and that all things hold equal, reinforcers established using operant discrimination procedures would be more effective as reinforcers compared to reinforcers established with pairing procedures.

The importance of the current study cannot be overlooked in terms of work with tokens economies and social reinforcers. There has been extensive work on conditioning involving the establishing of neutral stimuli as conditioned reinforcers. The literature reviewed pointed out that most of these studies have employed procedures of pairing and have reported some successes but these successes cannot be compared to those achieved by procedures employing operant discrimination to establish conditioned reinforcers.

Conditioned reinforcers play a key role in the work of therapists. It is not every time that one can present primary reinforcers to a participant in a therapeutic relationship in order to achieve a behavioral change. In most cases the biological constraints of satiating will not permit it, nor will it always be possible to obtain them. The only hope then is to find substitute reinforcers which will not be affected by these major problems yet be effective. Due to the problems of working directly with primary reinforcers, procedures for establishing conditioned reinforcers will always be paramount in the work of the behavior analyst. Some

examples bordering the use of conditioned reinforcers are that of token economies, awards, prizes, and scholarships, which support an enormous range of responses. Perhaps the most important example of a token economy reinforcer is money. One way to understand the reinforcing effects of money is to view it as a type of token (coins or bills) exchangeable at a later time for a variety of goods and services. Casinos have always employed poker chips as a form of reinforcer which when earned may be later exchanged for another form of conditioned reinforcer which could later be used to acquire a primary reinforcer. Experiments employing chimpanzees have also employed poker chips as conditioned reinforcers where they have been paired with primary reinforcers though these experiments do periodically have to strengthen the reinforcing value of the chips with intermittent provision of primary reinforcers (e.g. Cowles, 1937).

Social reinforcers vary from one society to another, yet their effects appear to be universal. All social animals rely on feedback from their environment to predict the frequency or response rate of their current behavior. A child earns a smile from the mother as a positive feedback (reinforcement) which increases the chances of you producing the response that resulted in the smile; a successful academic record resulting in a celebratory party for the successful candidate are all examples of instances in which social cues serve as conditioned reinforcers. Maybe the most important socially conditioned reinforcer is that of verbal feedback. Monologues tend not to last long, yet dialogs may run for a considerable period of time, and even in this instance there is no possibility of exchanging the feedback (verbal reinforcement) for a primary reinforcer, but so long as the feedback remains positive, the verbal response will continue to be evoked.

Pierce and Cheney report on the works of Lovaas and his collaborators since the 1960s, involving the application of behavioral treatment of autistic children, aimed at establishing and improving on rate of acquisition and maintenance of social behavior, teaching the child to

speak, and eliminate self-stimulation. These studies have all employed conditioned reinforcers and in Lovaas et al. (1966) there was an instance when pairing failed and operant discrimination succeeded in establishing a conditioned reinforcer. Most of the participants of Lovaas and his colleagues reported treatments, showed significant improvement in their daily functioning. Incredibly, when the treatment was applied to autistic children that were less than 30 months old, 50% of these children were later indistinguishable from normal school children. No other treatment of autistic children has produced such dramatic improvement (Lovaas, 1993; Schopler & Mesibov, 1994). This shows that discriminatively established reinforcers do have a stronger implication for the application of experimental designs in the actual modification of behavior.

The current results throw more light on conditioned reinforcers and the procedures which may be more applicable to establish them, easily and effectively and if the procedures hold true then surely behavior analyst cannot overlook effective better designs and dogmatically stick to less effective ones. It may be necessary to further study operant discriminative learning procedures in relation to conditioned reinforcers but until then, this study provides evidence that it is cost and time effective to resort to operant discrimination procedures rather than pairing for the establishment of conditioned reinforcers.

Conclusion

Ambulatory organisms are faced with the task of surviving in a changing environment (world). As a consequence, they have acquired the ability to learn. Learning ability is an evolutionary adaptation to transient order not lasting long enough for a direct evolutionary adaptation. The order is of two types: relations in the world (classical or Pavlovian conditioning) and the consequences of one's own actions in the world (operant or instrumental conditioning). Most learning situations comprise operant and classical components and, more often than not, it is impossible to discern the associations the animal

has produced when it shows the conditioned behavior. A recurrent concern in behavioral research, therefore, has been the question of whether contingency or contiguity based learning designs best establish conditioned variables; reinforcers for example.

Based on the results of the current study, I do believe that it is viable to strongly suggest that discriminative or operant learning may be the best direction to take in relation to conditioned reinforcers, after all if the designs do fail in establishing strong effective reinforcers, the organism would have come to learn that his responses do have consequences and at worst these consequences will exert stimulus control over subsequent responding, and if this control does later result in an increase in response rate; then is that not reinforcement.

The evidence from this study presents a strong case for discrimination based procedures as conditioning procedures, but as seen in the case of Ama, probably so will it have a strong case in the situation of conditioned stimulus control and attention, but for space the results for this participant was minimally discussed along those lines. It would be nice to conclude also that the results obtained here are definite, but it would not be possible, since the experiment involved only two participants and as such might not generalize across the human population; future experiments would present a stronger purpose if it was run with a larger population and also if its results were compared to results obtained from animal-run experiments of the same procedures. The results might possibly also be biased due to procedure sequence effect. Since the discrimination procedure was run first before the briefly paired procedures, one might argue that information before and information after might have resulted in the response patterns observed. To counter for such a possible argument, the experimental design ensured that temporal time between training sessions and post tests were fairly similar and that both procedures were subjected to a closely linked running time in lieu with sessions. Also Experiment 2 helps to show that the sequence in which the procedures were run had little or no effect on the experimental results; considering that the boost sessions

in Experiment 2 run the discrimination based procedure first before the briefly paired procedure and as such responding contingent to the briefly paired reinforcer should have been higher since it was temporally closer to the post test than the discrimination established reinforcer. Another factor that possibly could have affected the results in this study is that of the values of the different types of reinforcers used in this experiment both conditioned and previously unconditioned reinforcers as relating to the participants. The arbitrary stimuli which served as conditioned reinforcers were virtually similar to both participants, with one (cassette case with pink paper inlay) serving as a conditioned reinforcer on the briefly paired procedures for one participant (Kofi) and as a discriminatively established reinforcer for another (Ama), yet responding to this stimuli in both participants was not observed to have been affected., which presents a stronger case for the procedures used as having served to transfer reinforcer values onto the conditioned reinforcers. Also some of the primary reinforcers overlapped across participants and as such any differences in response patterns in the post test sessions can not be argued on the grounds of the possible effects of the different types of primary reinforcers used. This study only serves as the beginning of a long journey in finding the most effective design for establishing conditioned reinforcers, and so far the journey appears to be intriguing and promising.

References

Bernal, M. E. (1965). *GSR Studies of autistic children*. In: Paper presented at the 73rd Annual meeting of the American Psychological Association, Chicago

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis*, 2nd ed. Upper Saddle River, N.J.: Pearson Prentice Hall.

Cowles, J. T. (1937). Food-tokens as incentive for learning by chimpanzees. *Comparative Psychology Monographs*, *14*, 1–96.

Cohen, S. L., & Branch, M. N. (1991). Food-paired stimuli as conditioned reinforcers: Effects of d-amphetamine. *Journal of the Experimental Analysis of Behavior*, *56*, 277-288.

Cohen, S. L., & Calisto, G. (1981). The effects of brief-stimulus presentations in fixed-ratio second-order schedules. *Journal of the Experimental Analysis of Behavior*, *36*, 329-342.

Dinsmoor, J. A. (1950). A quantitative comparison of the discriminative and reinforcing functions of a stimulus. *Journal of Experimental Psychology*, *40*, 458-472.

Kelleher, R. T. and Gollub, L. R. (1962). A review of positive conditioned reinforcement. *Journal of the Experimental Analysis of Behavior*, *5*, 543-597.

Lovaas, O. I. (1993). The development of a treatment–research project for developmentally disabled and autistic children. *Journal of Applied Behavior Analysis*, *26*, 617–630.

Lovaas, O. I., Freitag, G., Kinder, M. I., Rubenstein, B. D., Schaeffer, B., and Simmons, J. Q. (1966). Establishment of social reinforcers in two schizophrenic children on the basis of food. *Journal of Experimental Child Psychology*, *4*, 109-125.

Maltzman, I. and Raskin, D.C. (1965). Effects of individual differences in the orienting reflex on conditioned and complex processes. *Journal of Experimental Research in Personality* 1, pp. 1–16

Myers, J. L. Secondary reinforcements: A review of recent experimentation. *Psychological Bulletin*, 55,284-301.

Norton R. (1988). Cumulative recorder program. Retrieved 18 March, 2009 from http://www.livevideo.com/media/tag/ridanos-atferdsvitenskap.aspx

Ratner, S. C. (1956). Effect of extinction of dipper-approaching on subsequent extinction of bar-pressing and dipper-approaching. *Journal of Comparative & Physiological Psychology., 49*, 576-581.

Schoenfeld, W. N., Antonitis, J. J., & Bersh, P. J. (1950). A preliminary study of training conditions necessary for secondary reinforcement. *Journal of Experimental Psychology, 40*, 40-45.

Schopler, E., & Mesibov, G. B. (1994). *Behavioral issues in autism*. New York: Plenum.

Wyckoff, L. B., Sidowski, J. and Chambliss, D. J. (1958). An experimental study of the relationship between secondary reinforcing and cue effects of a stimulus. *Journal of Comparative & Physiological Psychology 51*, 103-109.

Zimmerman, D. W. (1959). Sustained performance in rats based on secondary reinforcement. *Journal of Comparative & Physiological Psychology*, *52*, 353-358.

Appendixes

Graphs

Section A: Pretests for responses and neutral stimuli

1. Kofi

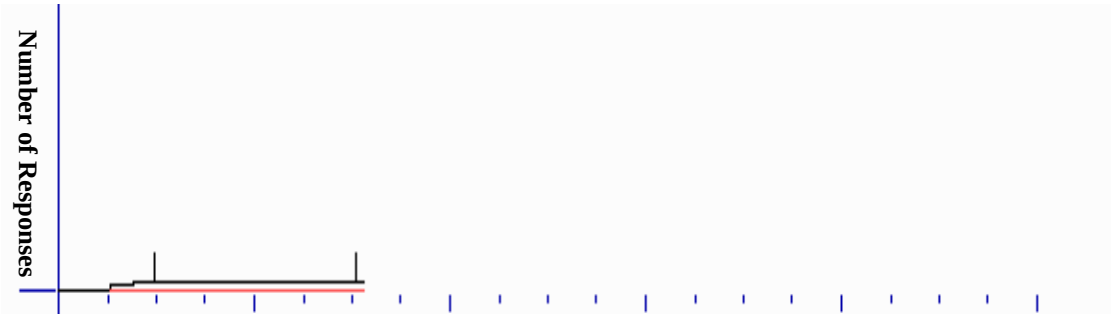


Figure 3: Test for automatic reinforcer on AC

Figure 4: Test for automatic reinforcer on RSS

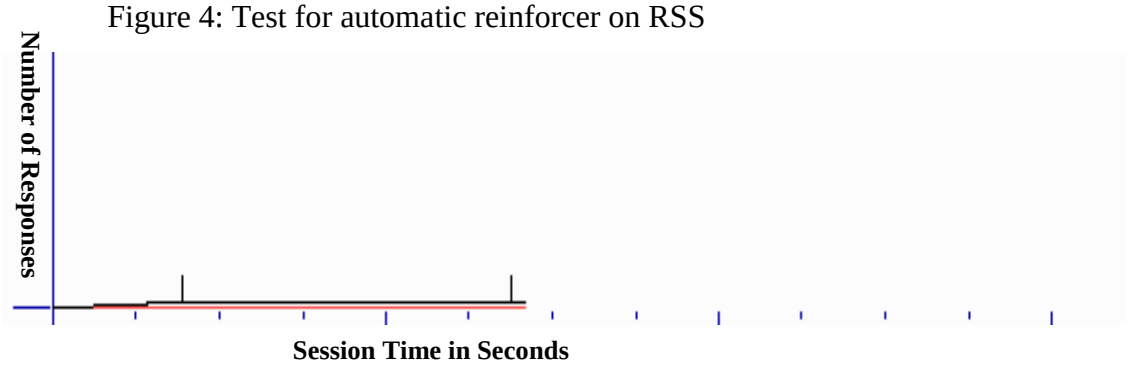


Figure 1: Test for automatic reinforcement on response YPH

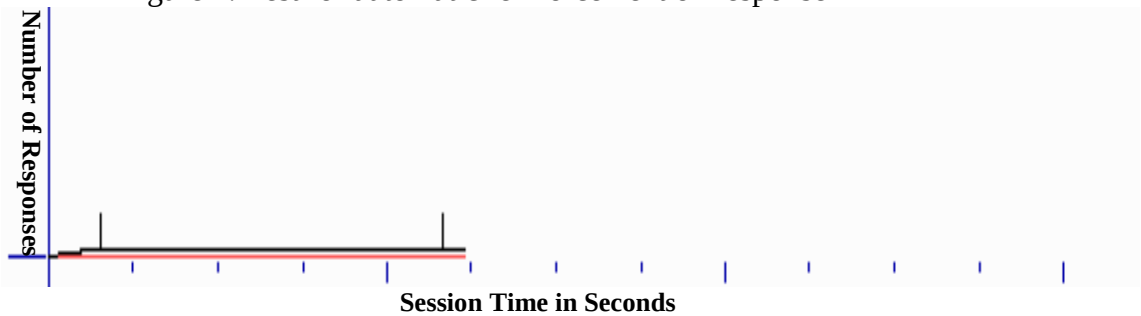


Figure 2: Test for automatic reinforcement on response HWP

2. AMA

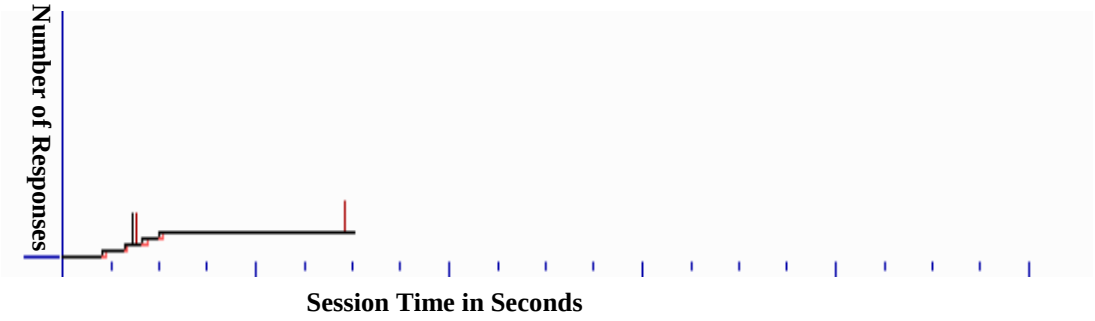
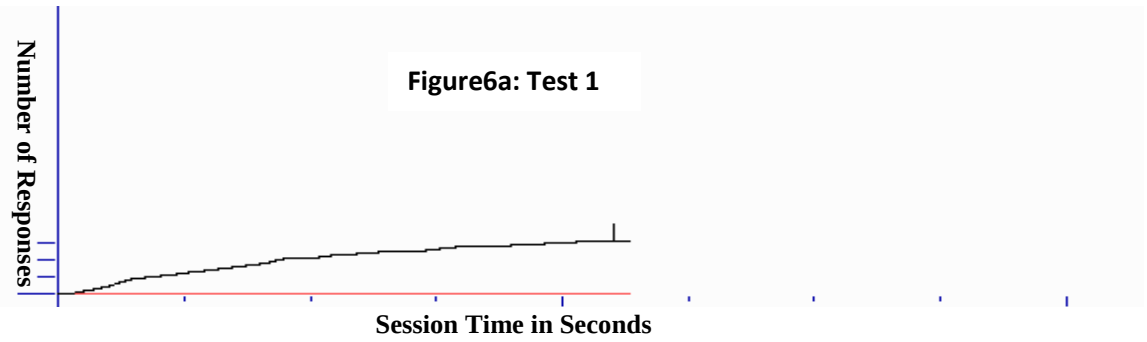
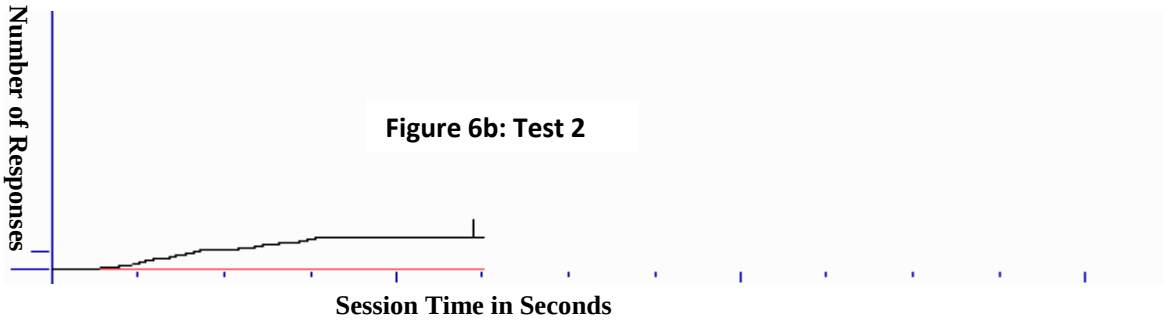


Figure 5: Tests for automatic reinforcer in Audio Cassette case (the red line graph helps to show the temporal distance between Audio Cassette and the test response)





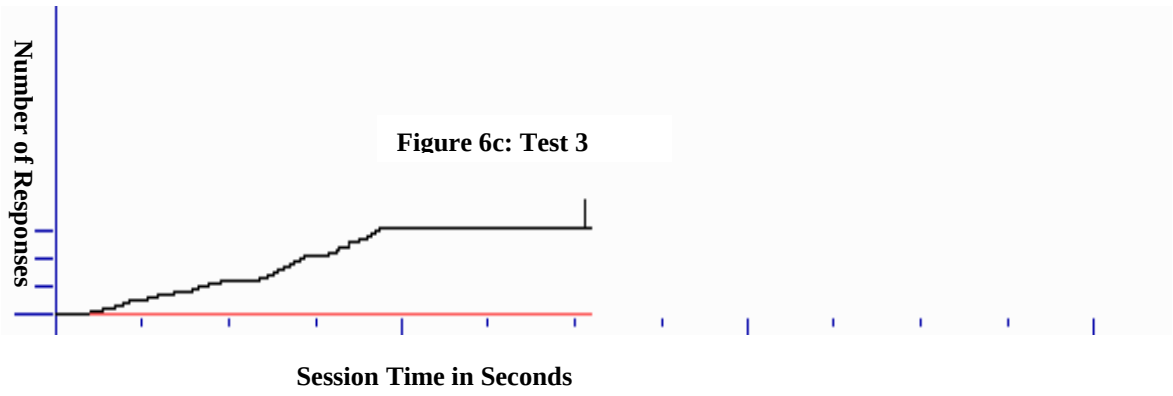
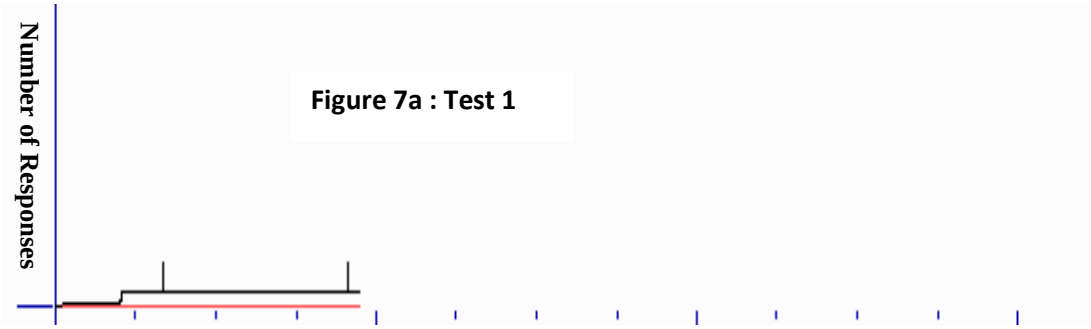


Figure 6 (a b & c): Shows test results for automatic reinforcement test in Red/Green paper circle on “hands up” response.



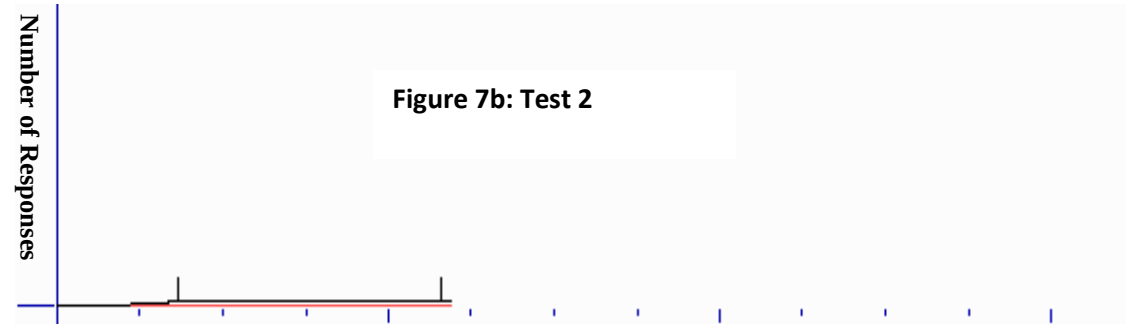


Figure 7 (a & b): shows test results for automatic reinforcement on Pink Strip of Paper situated on the left hand corner of experimenter and under operation of experimenters index finger.

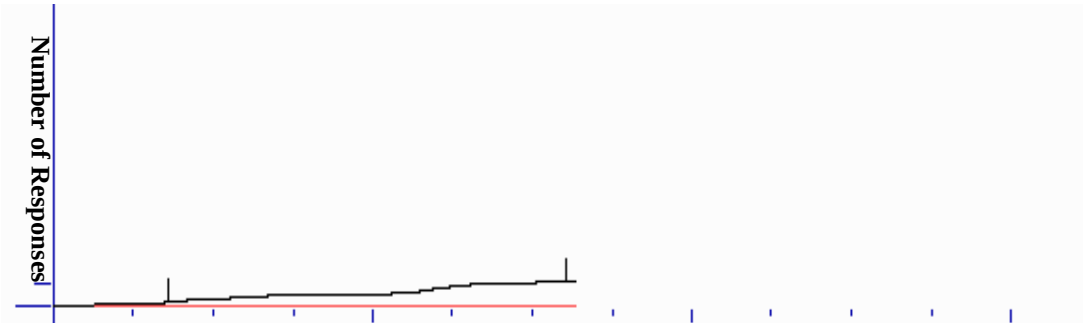
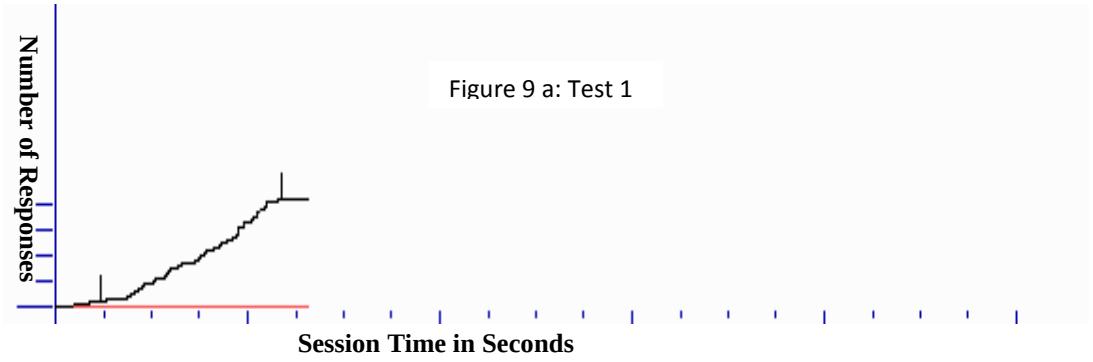


Figure 8: shows results for test for automatic reinforcement on a complex response of Hands Up – Hands Knee – Hands Table on the presentation of White Paper Covering Yellow Strip of Paper on far right hand corner of table from the experimenters sitting position.



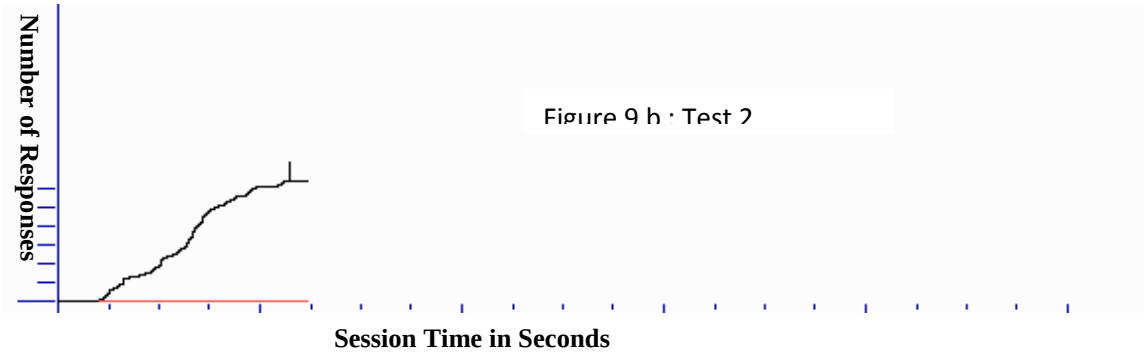
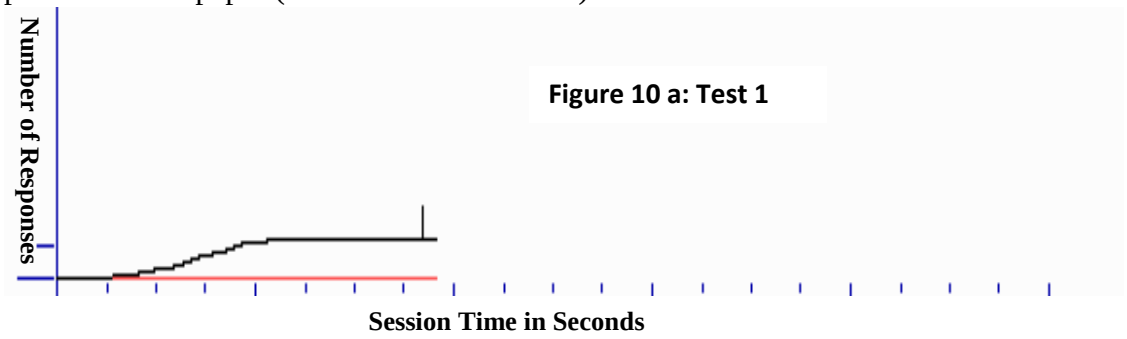


Figure 9 a & b: shows results for a test of automatic reinforcement in the response of "placing palm on white paper (A4 sheet folded in half).



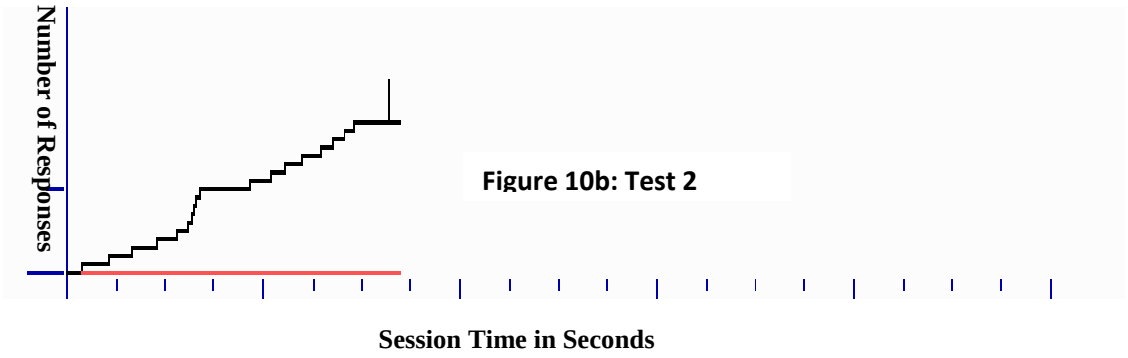


Figure 10 a & b: Presents test results for the response of placing a yellow Lego platform on her head in an a test for determining the influence of automatic reinforcement on the said response.

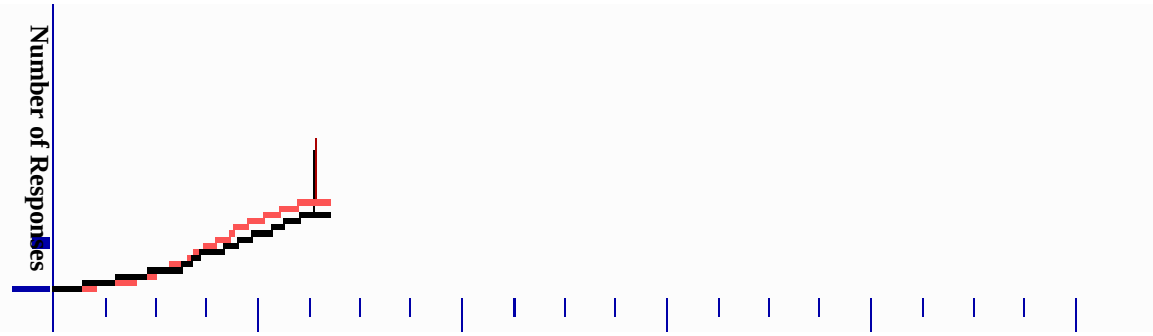


Figure 11 shows Ama's response pattern on multiple but competing responses. The Black line represents responding in "crossing over fence" as already described for Kofi, but this time one response was "twice over the fence". The Red line represents responding on placing a "yellow Lego platform on the head." The notion of using these already tested responses was to find out if one would thin out the other. But the results show no thinning out in any of the responses.

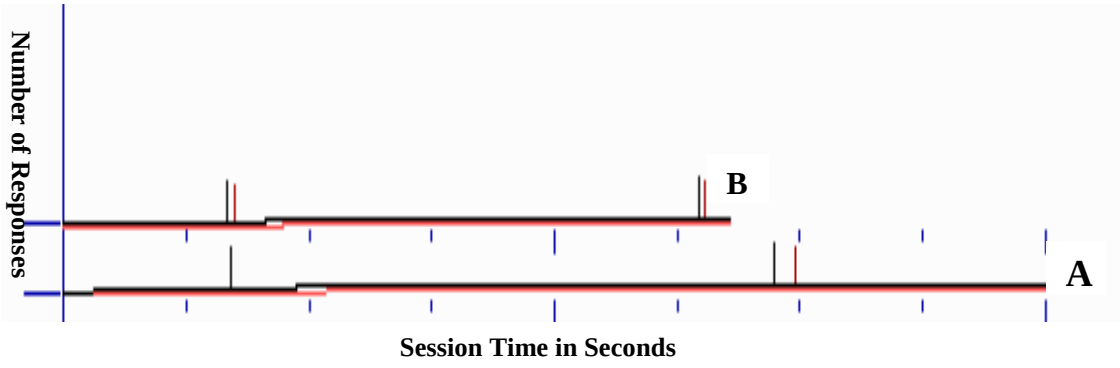


Figure 12 presents results for automatic reinforcement in a complex response. Multiple responses of varying topographies were prompted in a random sequence and not respective to arrangement of responding stimuli on the experimental table. **A** represents response frequency in "cross over fence" (Black) and "yellow Lego platform to head" (Red); whilst **B** shows results for: "rub fuzzy green turtle on cheeks" (Black) and "place colorless plastic bowl

on tummy" (Red). Note most of these responses had already been tested and had shown to be automatically reinforced on their own, but when incorporated into complex chain of responding, they did not occur more than once after prompting. Note that even though the graphs are stacked one on the order. The responses were all in the same session and are graphed according to how the responding stimuli were arranged on the table, not in the sequence in which they were engaged.

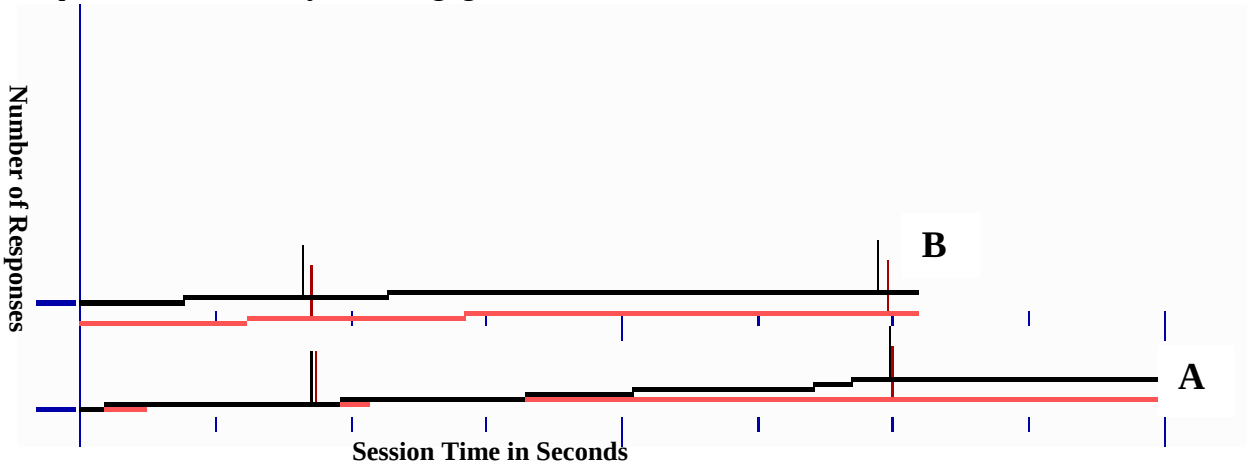
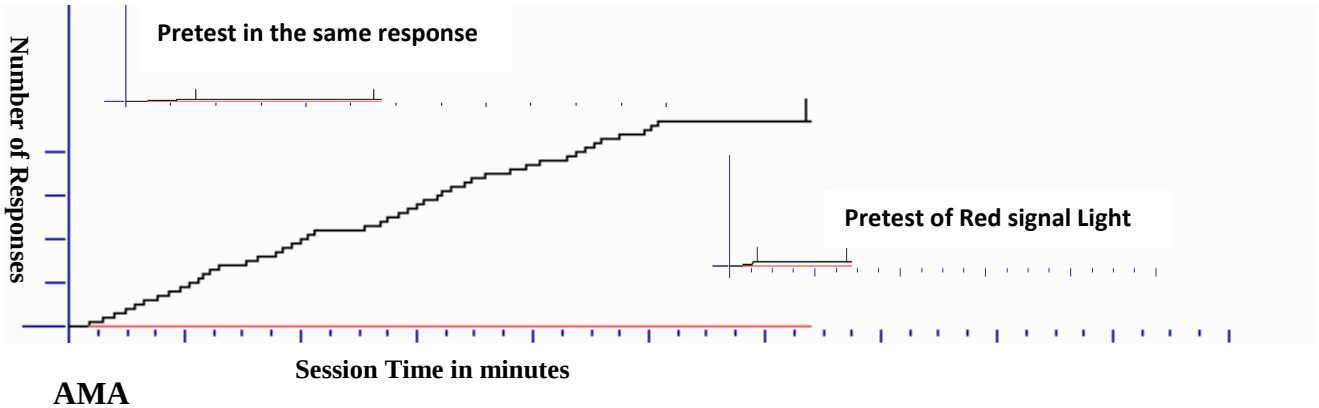


Figure 13 shows responding in another complex arrangement of different responses with different topographies. Where **A** shows response frequency for responses "fix and un-fix a plastic Lego puzzle of two pieces only" (Black) and " Place toy nokia mobile phone on cheeks" (Red); whilst **B** presents results in the same session for "clap on green plastic board" (Black) and "fix and un-fix wooden train tracks of two pieces only" (Red). As shown in the graph above, only the second response on **A** was not engaged in more than once after prompting and even though the others did have a few instances of responding on them, they did run into extinction.

POST TEST FOR OPERANT DISCRIMINATION PROCEDURE

KOFI:

Figure 14: Graph showing response frequency of "yellow Lego platform to head" made contingent on conditioned reinforcer (Red Signal Light). Inserted is the same response topography in a pretest for automatic reinforcement following 2 prompts.



AMA

Figure 15a & b: Responses for putting yellow cylinder in 2nd hole of 4 sequentially placed holes in a wooden block (prompted 3rd in prompt sequence) and ignoring the rest on a discriminatively established reinforcer (inter scorer agreement was about 82%).

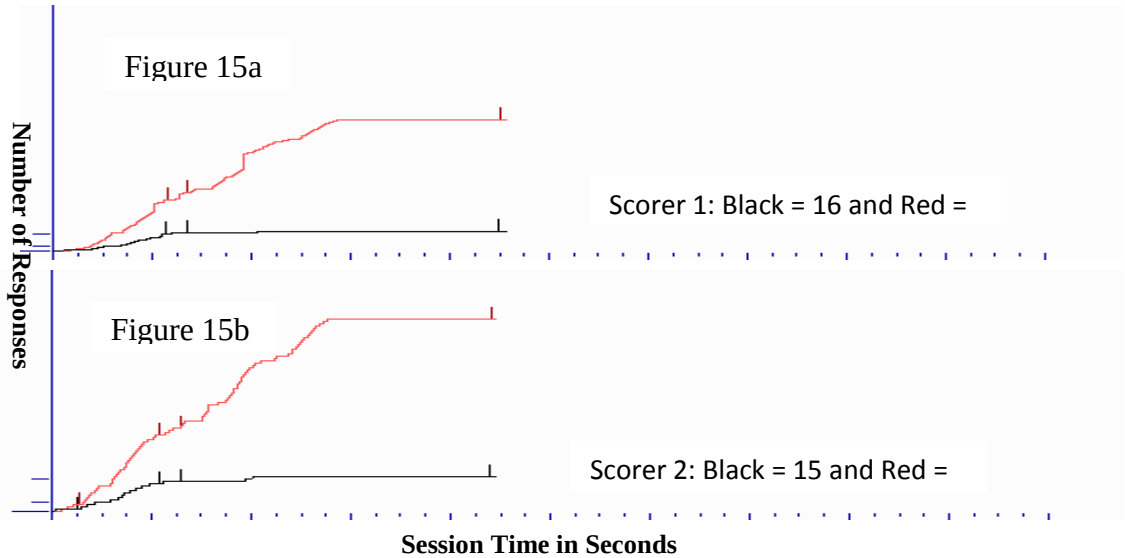
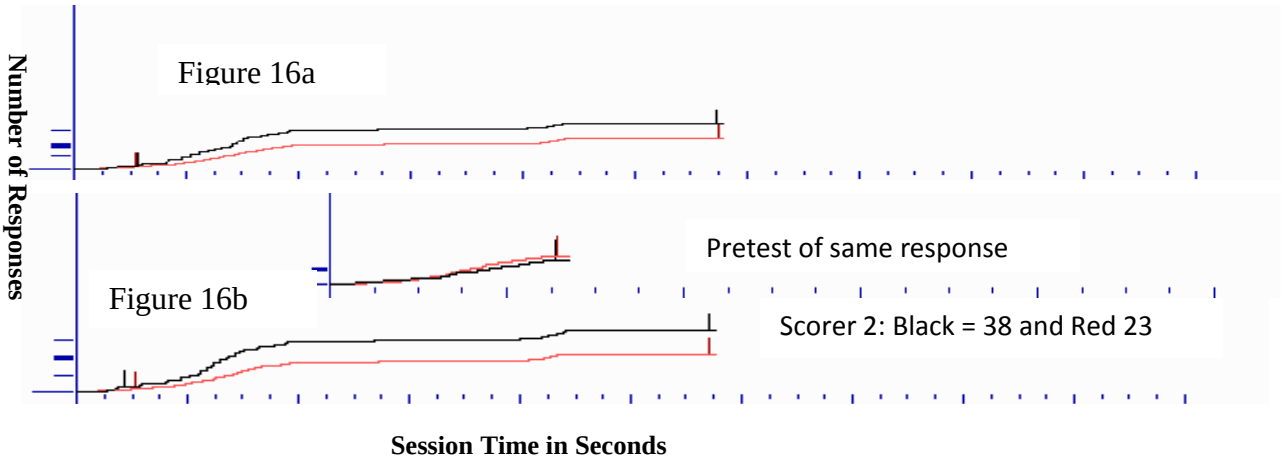


Figure 16a & b: Post tests response for Ama on multiple but competing responses. The Black line represents responding in "crossing over fence" as already described for Kofi, but this time one response was equals to "twice over the fence". The Red line represents responding

on placing a "yellow Lego platform on the head". Only the cross over fence was contingent on the discriminatively established reinforcer (inter scorer agreement was about 96%).



POST TEST FOR BRIEFLY PAIRED STIMULI

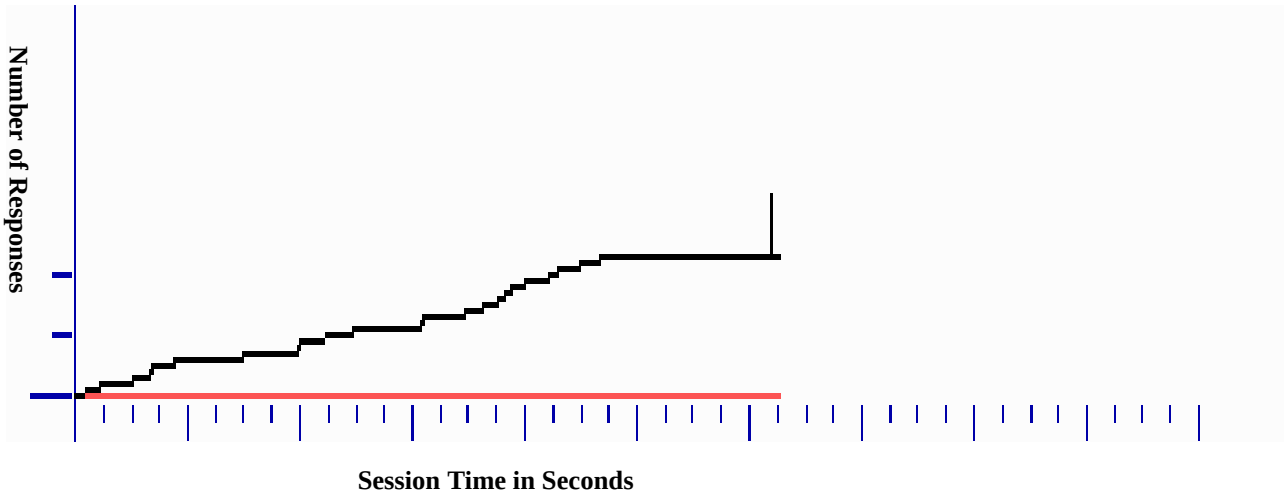


Figure 17 (Kofi): Response (hand on A4 white paper folded in half) frequency contingent on a conditioned reinforcer established through brief pairing stimuli (Empty Pink Paper inlayed Audio cassette)

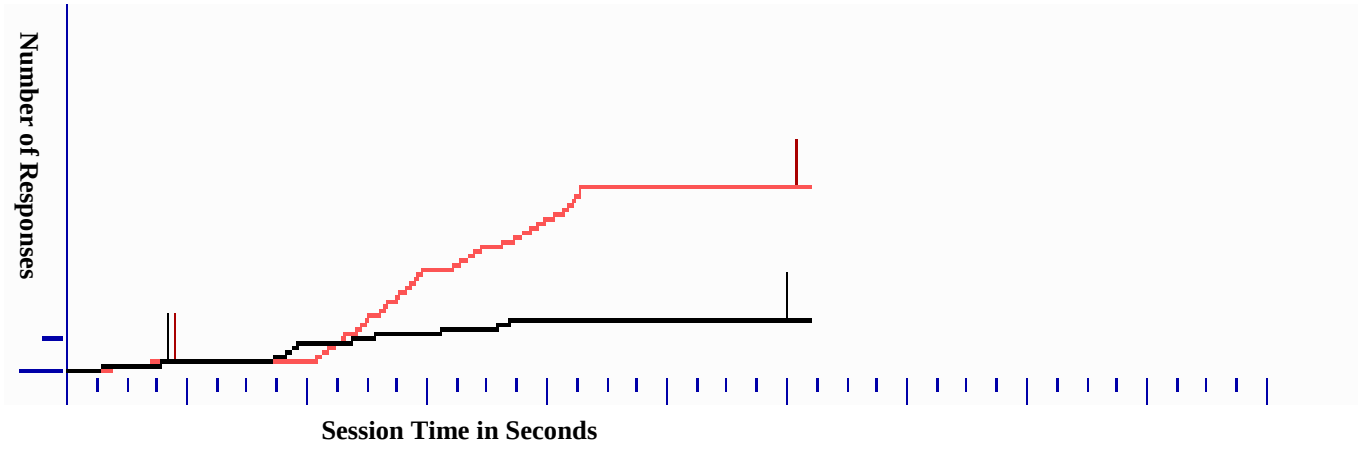


Figure 18: Response (Tacting of color papers; lime green and blue; with a red plastic circle) frequency on a conditioned reinforcer established through brief pairing of stimuli (Empty Pink Paper inlayed Audio cassette). Just as in the post test of S^D procedure, the responses here were competing with each other but only one had the conditioned reinforcer contingent on it (Responding on the Lime Green Paper). Black = Lime Green Paper; Red = Blue Paper

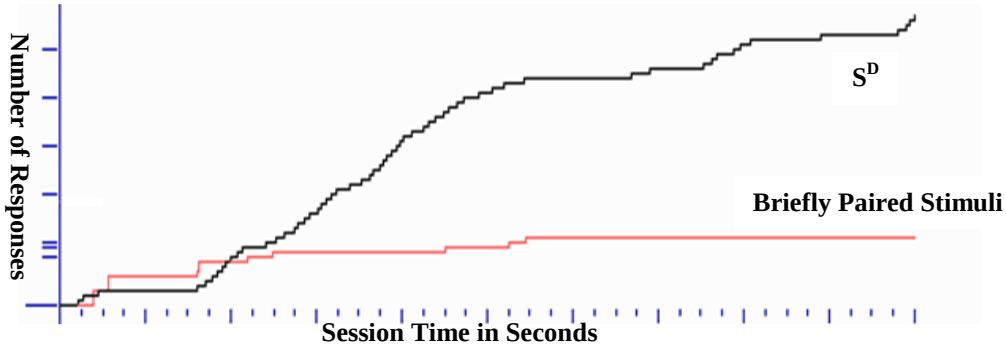


Figure 19: Response rate of two competing responses evoked by two conditioned reinforcers established by different experimental designs. Black = S^D established reinforcer (Red Signal Light) made contingent on "place yellow lego platform to head"; whilst Red = briefly paired stimuli established reinforcer (empty pink inlaid Audio Cassette case) made contingent on the response "place palm on white paper on table".

Tables:

Table 2[a]: Primary Reinforcer (Edibles) selection for Kofi

Reinforcers	Container Colors	Position on selection choice	2nd Test
Gummy Worm Toffee (gummies)	Colorless	3	2
Liquorices (no flavor)	Red	1	1
Liquorices (lemon flavor)	Blue	4	4

Salted Biscuit	Blue	2	3
Chocolate	Yellow	6	7
Coca cola (sugar free)	Green cup	7	6
Carmel Toffee	Blue	5	5

Table 2[b]: Primary Reinforcer (edibles) selection for Ama

Reinforcers	Container Colors	Position on selection choice	2nd Test
Gummy Worm Toffee (gummies)	Colorless	2	3
Liquorices (no flavor)	Red	None selected	None selected
Liquorices (lemon flavor)	Blue	None selected	None selected.
Salted Biscuit	Blue	1	1
Strawberry Drink	Yellow	4	2
Carmel Toffee	Blue	3	4

Table 3[a]: Primary Reinforcer (play items) selection for Kofi

Reinforcers	Position on choice selection
Beads on a loop (like an abacus)	5
Plastic spiders	3

Plastic Finger (with sound)	4
Plastic Lens (Sherlock Holmes style)	2
Plastic Mic (battery operated)	6
Toy Plane (battery operated with sounds)	7
Fuzzy troll toy	1

Note: there was no second testing for preference levels for play items.

Table 3[b]: Primary Reinforcer (play items) selection for Ama

Reinforcers	Position on choice selection
Softball Cannon (reloadable with 6balls)	6
Winding Horse	5
Doll sitting in a swing	3
Catapult	7
Egg like toy	4
Winnie the Pooh replica	8
Fuzzy Green Doll	1
Stickers (with Ting-a-ling pictures on them)	2

Table 4 shows a chronological representation of S^D procedure for both participants:

Schedule	Number of Sessions		Number of trials		Trial Position in experiment	
	KOFI	**AMA**	**KOFI**	**AMA**	**KOFI**	**AMA**
VT 4sec	**4**	**2**	**30**	**21**	**01 – 30**	**0 – 21**
VT 7sec	**2**	**1**	**11**	**8**	**31 – 41**	**22 – 29**
VT 15sec	**3**	**2**	**20**	**11**	**42 – 61**	**30 – 40**
VT 15sec. (<VT≥9/10 ccr)	**3**	**3**	**25**	**22**	**62 – 86**	**41 – 62**
3ccr1min	**1**	**2**	**3**	**8**	**87 – 89**	**63 - 70**
3ccr2min	**3**	**3**	**13**	**9**	**90 - 102**	**71 - 79**
3ccr5min	**2**	**2**	**7**	**7**	**103 – 109**	**80 – 86**