BEHAVIOURAL ANALYSIS OF TEMPTATION IN A SOFT COMMITMENT PARADIGM

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ABBREVIATIONS

Shorter sooner	SS
Longer larger	LL
Fixed Ratio 31	FR 31
Fixed Interval 30	FI 30
Continuous Reinforcement Schedule	CRF
Fixed Ratio 31 temptation	FR 31 tempt
Second (s)	s

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ABSTRACT

In Experiment 1, we partially replicated Siegel and Rachlin's (1995) study of soft commitment, whilst controlling for order effects. "Soft commitment" refers to a situation in which self-control is enhanced by an extended behavioural pattern where the larger-later (LL) outcome is obtained over the shorter sooner (SS) outcome. Results showed that the effect of 'soft commitment' was greater with fixed-ratio 31 (FR 31) schedules compared to the fixed-interval (FI 30) schedules. Therefore, the results of the present study were consistent with Siegel and Rachlin's findings where soft commitment was shown in the FR 31 condition.

In Experiment 2, we explored the effects of a 'temptation' analogous to a human context. FR 31 choice trials were interrupted with a temptation cue (i.e., a red centre key that indicated immediate accessibility to SS reinforcement). Temptation cues were presented at different response locations during the trials. The findings showed that the probability of pecking the temptation key and the latency to respond ('succumb') changed systematically depending on response location. This suggested that pigeons showed a better resistance to yield to temptation when the cue was presented later rather than earlier during the FR 31.

INTRODUCTION

General Introduction

A hallmark of behaviourism and operant behaviour analysis is its emphasis on empiricism (Skinner, 1953). Behaviour analysis is dedicated to discovering the laws of behaviour by virtue of ongoing research towards prediction and experimental control. In particular, one of the most successful areas of research in behaviour analysis is the "self-control" paradigm.

Skinner (1953) first discussed self-control in terms where two outcomes are related to each other in a special way. Generally, self-control refers to the organism that controls their own behaviour when presented with conflicting choices that leads to either positive or negative reinforcement (Skinner, 1953). For instance, a positive outcome may involve one who gets drunk and meets a new partner. Since this is positively reinforcing it thus increases the likelihood of having further drinks with this person.

In contrast to positive reinforcement, irresponsible drunken behaviour or the physical detriments of hangover effects are negative events. As a result, when contingent upon such behaviour this denotes a type of punishment (e.g., when the new partner ceases to make contact). Reduction of this negative consequence can be made by environmental changes that are associated with irresponsible drunken behaviour. Any behaviour which weakens the drinking (e.g., meeting over a cup of tea and not

getting drunk) is reinforced and thus reduces aversive outcomes. The behaviour that displaces punishable behaviour is known as self-control.

Further, self-control in humans has often been studied in terms of delay of gratification. For example, Mischel and Ebbeson (1972) reported an extensive series of studies in which children made choices between waiting for a smaller, immediate reward (e.g., a pretzel) or a larger, delayed reward (e.g., an animal cracker). Self-control was shown when the children were able to wait longer to receive the larger, delayed reward over the smaller immediate reward.

Similar findings were obtained with non-humans. Rachlin (1974) found when pigeons were presented with a choice between a shorter sooner (SS) food reinforcer (e.g., 2.5 seconds (s) access to wheat grain, available after a 0.5-s delay) and a longer larger (LL) food reinforcer (e.g., 4-s access to wheat grain, available after a 4-s delay), self-control was shown when the LL reinforcer was chosen. These two sources of evidence support the area of self-control, but nonetheless there are other forms of self-control, which emerge as a function of environmental contingencies (see Skinner 1953 for review). By contrast, impulsive behaviour was shown when the pigeon(s) chose the SS reinforcer over the LL reinforcer (Ainslie, 1974).

Research on self-control with both human and non-human subjects has increased steadily over the years. The importance of self-control for human behaviour is demonstrated by the many applications of basic research findings to applied contexts (see Logue, 2002, for review). Although a clearer understanding has emerged regarding the variables of which "self control" is a function (e.g., reinforcer delay and magnitude), other aspects require further investigation.

One important aspect concerns the role of "commitment" (Rachlin & Green, 1972; Siegel & Rachlin, 1995; Green & Rachlin, 1996; Rachlin, 2000). According to Rachlin and colleagues, commitment may take either of two forms. The first type is "Strict" commitment. Strict commitment refers to a current choice that restricts future choices (Rachlin, 2000) For instance, moving the alarm clock to the far side of the bedroom before going to sleep. As a result, this choice eliminates the opportunity to choose impulsively (e.g., hitting the snooze button to obtain an extra 10 minutes sleep).

The second type, which is more pertinent to the present study, is "Soft" commitment. "Soft" commitment is shown when there is no imposed act that stops switching between alternatives. Instead, with soft commitment, costs are incurred when a switch breaks an extended pattern (i.e., repeatedly pursuing the preferred outcome). The extent of such a cost would increase with the longevity of the pattern and increasingly discourages switching. Costs such as obtaining a poor thesis grade by attending parties may prevent switching and thus promote self-control (e.g., consistently working on the thesis and obtaining a good grade).

In an experimental paradigm, investigating preferences places an organism into a context where it can choose between differing conditions of reinforcement thus obtaining either the SS or LL reinforcer. Preference may be measured in terms of response or time allocation (Catania, 1969; Baum & Rachlin, 1969). However, in the natural environment, an animal's choices may be much more numerous (Ishii & Sakagami, 2002; Mazur, 2001). The presentation of an additional impulsive choice during or after selection of a choice may be referred to as a "temptation" (Ishii & Sakagami, 2002). To date, no research has studied the effects of temptation

manipulations as a clearly defined and measurable response in an operant paradigm. Therefore examining the effects of impulsiveness or self-control where a temptation stimulus interrupts other reinforcement schedules is worthy of further investigation.

The current study sought to replicate and extend Siegel & Rachlin's (1995) study on "soft commitment". In Siegel and Rachlin's experiment, trials began with two illuminated keys in an operant chamber. Siegel and Rachlin showed that choice for the longer larger (LL) outcome was greater when the response requirement was in the Fixed Ratio 31 (FR 31) trials. A FR 31 trial consisted of 31 pecks where the pigeon could peck on either key. When the 31st peck was made on the shorter sooner (SS) key, the pigeon obtained 2.5-s of food that followed a 0.5-s delay. On the other hand, if the 31st peck was made on the longer larger (LL) key the pigeon obtained 4-s of food that followed a 4-s delay. Results suggested that the FR 31 condition showed a strong pattern of soft commitment because there was a stronger preference for the LL outcome. By contrast, to the FR 31, the Continuous Reinforcement (CRF) Schedule where a one-peck requirement was needed on either the SS or LL alternative showed a strong preference for the SS reinforcer.

One limitation that was reported in the Siegel and Rachlin study was that order effects might have been present in the experiment. Therefore, to provide a better controlled comparison of results our aim was to minimise order effects by using an ABA design to counterbalance between the different conditions.

The second aim of this study was to develop a preliminary behavioural model for temptation using a soft commitment paradigm with pigeon subjects. This temptation model is an extension to the soft commitment research conducted by

Siegel and Rachlin. In addition, efforts were made to investigate the effects of temptation or pattern interruption on self-control. The temptation cue or stimulus was a centre key that was illuminated for 3-s and was systematically programmed and presented at certain response locations on specified FR 31 trials. If the pigeon pecked on this key rather than the SS or LL alternative, they received a reinforcer that equated to the SS food reinforcer. Furthermore, latency times to responding or not responding to the temptation cue were recorded and analysed.

The next section reviews the literature on models of choice. Special attention is paid to concurrent chains and their use in research on self-control (Hernstein, 1961; Baum & Rachlin, 1969; Baum, 1974; Logue, Rodriguez, Pena-Correal & Mauro 1984; Grace, 1994). The third section provides a review of the operant and human self-control research and related areas such as commitment and soft commitment behaviour. The fourth section provides a summary of clinical evidence identifying temptation processes within addiction and dependence disorders. In the fifth section, the introduction ends with the main rationale and outline of the current study.

Choice Behaviour

What is choice?

A number of choice experiments with both non-humans and humans have obtained results that demonstrate self-control (Mischel & Ebbeson, 1972, Navarick & Fantino, 1976; Grosch & Neuringer, 1981, Schweitzer & Sulzer-Azaroff, 1988, Grace, 1999). Moreover, research in choice has contributed to the development of quantitative models (e.g., Hernstein, 1961; Baum and Rachlin, 1969; Baum, 1974; Logue, Rodriguez, Pena-Correal and Mauro, 1984; Grace, 1994). One reason for this is that choice behaviour is often remarkably orderly in the laboratory setting (Mazur, 1997). On the other hand, behaviour in the animal's natural environment may be highly variable (e.g., pecking at a wide range of objects) making it scientifically problematic (Fisher and Mazur, 1997). Moreover, basic experiments that demonstrate preference to reinforcers that differ in terms of delay and magnitude is systematically measured by the distribution of responses (Rachlin, 1976; Fisher and Mazur, 1997; Grace, 1999).

Central to the self-control paradigm are the quantitative models of the matching law which provide a framework for describing choice in the concurrent chains procedure. This section focuses on a review of studies involving the Matching Law and related extensions (Hernstein, 1961; Baum and Rachlin, 1969; Baum, 1974; Logue, Rodriguez, Pena-Correal & Mauro, 1984 and Grace, 1994). Some time will be spent on discussing in detail the historical context of choice models in relation to self-control.

The Strict Matching Law

Most basic experiments on instrumental responding have focused on the relation between response and reinforcement rate. In a well cited paper, Herrnstein (1961) varied the relative rate of reinforcement in concurrent variable interval (VI) ~~VI~~ schedules and observed how response allocation varied. A single VI schedule was associated with each alternative. In such a procedure, subjects are presented with two alternatives to respond to [namely the shorter sooner (SS) or the longer larger (LL) keys]. This procedure ensured that the reinforcer (e.g., food grain) was delivered at certain time intervals. An additional requirement called the change over delay (COD) was used to prevent responses from being immediately reinforced after switching from one key to another. Herrnstein's findings revealed the proportion of responses to each alternative approximately equalled the proportion of reinforcers obtained from that alternative. This elegantly simple relation is expressed in Equation 1, known as "the matching law".

$$\frac{B_L}{B_L+B_R}=\frac{R_L}{R_L+R_R} \qquad (1)$$

In Equation 1 B refers to responses that are emitted, R refers to obtained reinforcers, and the subscripts represent the different alternatives.

Although the strict matching law may not apply perfectly in all situations, matching is still widely accepted as a cornerstone in the quantitative analysis of choice. To extend the matching law's domain of applicability, further research has explored additional factors that might affect choice including delay and magnitude of

reinforcement (Baum and Rachlin, 1969; Logue, Rodriguez, Pena-Correal and Mauro, 1984; Grace, 1994).

The Concurrent Chains Procedure

Studies of choice for schedules of reinforcement have used the concurrent chains procedure developed by Hernstein (1964). The subject (e.g., a pigeon or a rat) responds on two or sometimes more concurrently available alternatives (the choice phase or initial link). The recorded responding rates on two or more operanda - e.g., levers, keys and foot pedals are known as the dependent variables (Rachlin and Green, 1972; Green and Snyderman, 1980). Responses on each alternative occasionally produce another stimulus associated with passage into the terminal link of the chain on that alternative (the outcome phase). Terminal links may be classified as delay procedures followed by access to a food reinforcer. As a result, the organism obtains food from the shorter sooner (SS) or longer larger (LL) reinforcers (Ishii & Sakagami, 2002). The independent variable has generally involved some difference in the conditions arranged during the terminal links such as differing rates of reinforcement. For instance, an independent variable might be the frequency of reinforcement during the terminal links (Lewis, 1981).

One advantage of using a concurrent chain is that they show measurable choice proportions and preference for either alternative (Fisher and Mazur, 1997). Further, preference is the distribution of responses in the initial links that allows entry into one of two terminal-link schedules (Snyderman, 1983; Fisher and Mazur, 1997; Grace, 1999). Put another way, preference can be described as the rate of responding of one alternative as a proportion of the responding overall rate on both (Lewis, 1980).

Another advantage of concurrent chains is that they are useful when investigating the effects of self-control that involves the subject showing a preference of the LL over the SS. That is, one terminal link schedule provides a large-magnitude reinforcer after a large delay (LL). In contrast, the other terminal link schedule is associated with a small-magnitude reinforcer available after a short delay (SS).

An extension of the Matching Law

Following Hernstein (1961) initial study, researchers contributed variations of the strict matching law to determine the generality of matching. Thus, Baum and Rachlin (1969) proposed that the matching law might apply to different aspects of reinforcement other than rate. They suggested that multiplying ratios corresponding to each different aspect of reinforcement value could represent the effect of different aspects.

$$\frac{B_L}{B_R}=\frac{R_L}{R_R}\left(\frac{1/D_L}{1/D_R}\right)\left(\frac{M_L}{M_R}\right)=\frac{V_L}{V_R} \qquad (2)$$

In Equation 2, B measures emitted responses, R measures the rates of reinforcers, D measures delay of reinforcement, M describes magnitude or the amount of reinforcement and V is the value associated with the left or right key. Consequently, Baum and Rachlin, (1969) suggested that the combination of rate, delay and magnitude determined the value of a particular alternative. Other relevant strengths of Equation 2 such as prediction for preference reversal are further discussed in the commitment section.

The Generalised Matching Law

Baum (1974) suggested there were three ways in which relative responding rates might deviate from the matching law. Firstly, under-matching refers to when the relative rates of responding are not as extreme as to the relative rates of reinforcement. Baum proposed that under-matching is a product of when individual organisms vary in their sensitivity to reinforcers. Further evidence of under-matching takes place when the subject switches more frequently between choice alternatives than predicted by the conventions of the matching law (Fisher and Mazur, 1997). Therefore, a changeover delay (COD) assisted in the reduction of this switching behaviour by preventing reinforcement until after a programmed time had elapsed. Secondly and in contrast to under matching, the overmatching phenomenon is best described when the rate of the ratio of responses is relatively extreme compared to the ratio of reinforcers. Thirdly, Baum found that most organisms often demonstrated a preference for one manipulandum; (e.g., a position of the chamber, or a colour of the key). A constant preference for one alternative that is independent of variations in relative reinforcement rate is commonly referred to as bias.

To draw distinction between the other quantitative Matching Law models, Baum added two parameters k and a as shown in Equation 3.

$$\frac{B_L}{B_R} = k\left(\frac{R_L}{R_R}\right)^a \tag{3}$$

In Equation 3, known as the generalised matching law, B expresses the frequencies of responding for either alternative, R expresses the obtained reinforcers from the left or right. This is a special case of the matching law in which k = 1 and a = 1. Commonly logarithmic transformations of both sides are taken (as seen in Equation 4).

$$Log(B_L / B_R) = aLog(R_L / R_R) + Logk \tag{4}$$

Typically, Equation 4 is applied by performing a regression with the log response and reinforcer ratios. The slope and intercept of the resulting line are a and log k, respectively. Under matching is indicated by $a < 1$, and over matching by $a > 1$. If $k \neq 1$ then choice is biased towards one alternative or the other.

The Generalised Matching Law applied to delay and magnitude

Previous choice models have shown good descriptions of varied stimuli, response and reinforcement under the matching law (Rachlin, 1976). However, these models had not accounted for individual differences. Logue, Rodriguez, Pena-Correal and Mauro, (1984) argued that individual differences refer to the subject's different reinforcement histories in a self-control paradigm. Additionally, Logue, Rodriguez, Pena-Correal and Mauro, (1984) suggested that if sensitivity to reinforcer size and delay of reinforcer

values varied due to genetic differences and experiences then Equation 5 could account for individual differences as well.

$$\frac{B_L}{B_R} = k\left(\frac{1/D_L}{1/D_R}\right)^{sD}\left(\frac{M_L}{M_R}\right)^{sA} \tag{5}$$

In Equation 5, B represents the number of choices of reinforcer, D represents the delay, M represents the magnitude or amount of reinforcer, k represents a response bias, sD represents a subject's sensitivity to variations in the delay of reinforcer and sD represents a subject's sensitivity to the variations of reinforcer size.

In this study, the authors employed a fading procedure by decreasing delays to the shorter sooner (SS) reinforcers. The procedure also increased delays to the longer larger (LL) reinforcer. Findings showed that when subjects were exposed to fading conditions they were more sensitive to variations of reinforcer size than reinforcer delay compared to subjects who did not receive exposure to fading conditions. These results suggested that sensitivity to amount and delay might change depending on the subject's reinforcement history. As a result, such reinforcement characteristics may contribute to individual differences in self-control.

The Contextual Choice Model

Grace (1994) has provided a further extension of the generalised matching law. The author proposed and developed the contextual choice model (CCM).

$$\frac{B_L}{B_R} = k\left(\frac{R_L}{R_R}\right)^{a}\left(\left(\frac{1/D_L}{1/D_R}\right)^{sD}\left(\frac{M_L}{M_R}\right)^{sA}\right)^{(Tt/Ti)} \qquad (6)$$

In Equation 6 the CCM is based on the generalised matching law. Specifically, relative response rate in the initial link matches relative rates of terminal link entries (R_L / R_R), and the effect of terminal-link schedules is represented by separate ratios for relative immediacy and magnitude of reinforcement. There are four parameters: bias (k) sensitivity to terminal-link entries (a), terminal-link delay (sD) and magnitude (sA). The unique feature of the CCM quantitative model was its temporal context effects shown by the additional exponents (Tt/Ti). The temporal context in this model expresses the impact on choice of variations in overall initial and terminal link duration (Grace, 1994).

The CCM model provides at least a good approximation to choice data in a self-control paradigm (Grace, 1999). In this study, Grace (1999), assessed whether sensitivity to delay depended on the magnitude of reinforcement. Pigeons were exposed to a two-component chain procedure where delay to reinforcer was different for the two terminal links in each component, but the same across components. Reinforcement magnitudes were small in one component and large in the other.

Overall Grace's (1999) findings were consistent with the assumptions of the matching law in that delay and magnitude have independent effects on choice. Additional results provided minimal support for the view that sensitivity of choice to delay varied inversely with the magnitude of reinforcer. Therefore, the CCM is able to account for some of the deviations from predictions of the Generalised Matching Law in self-control studies (Grace, 1999).

Self Control

> *"...some maybe surprised to learn that my Science and Human Behavior (1953a) is said to be the first text in psychology to have a chapter of self-control. We do control ourselves, but not as initiating agents. We control ourselves as we control the behavior of others (by changing our environment), but we do so because we have been exposed to contingencies arranged by the social environment we call our culture."*
>
> Skinner 1988, p 32

Self-control refers to a procedure where the organism prefers a larger more delayed reward over a smaller, immediate contingent reward (Rachlin, 1970; Mazur and Logue, 1978; Logue and Mazur; 1981; Logue, 1988; Mazur, 1991; Nevin and Fuld, 1993; Rachlin, 1995; Chelonis, Logue and Tobin, 1994; Chelonis and Logue, 1996; Logue, 1996; Mazur, 1998; Grace, 1999; Rachlin, 1995; Rachlin, 2000). This form of self-control derives from principles of choice performance under concurrent schedules of reinforcement (Skinner, 1938; Logue, Rodriguez, Pena-Correal and Mauro, 1984). Further, developments of self-control in a choice context has been shown when delay and magnitude of the reinforcer are independent from each other (Grace,1999).

Much of the research on self-control has used pigeons as subjects. For instance, a pigeon makes a choice between a longer larger (LL) reinforcer (e.g., 4-s access to food preceded by a 4-s delay), by pecking at one response key, versus a shorter sooner (SS) reinforcer (e.g., 2.5-s access to food preceded by a 0.5-s delay) made available at a second key. Self-control is shown when the pigeon obtains LL reinforcement over the

SS reinforcement. (Rachlin, and Green, 1972; Rachlin, 1995; Logue, 1995; Grace, 1999; Rachlin, 2000). Similar experiments were performed with humans and similar results were obtained (Mischel & Ebbesen, 1970; Mischel, Ebbesen, & Zeiss, 1972; Mischel, 1974; Mischel & Patterson, 1976; Mischel, 1981; Mischel, Shoda & Peake, 1988; Mischel, Shoda & Rodriguez, 1989; Mischel, Cantor, & Fieldman 1996). However, the aforementioned is only one description of self-control, as self-control can be characterised in many forms (see Skinner, 1953 for review).

In contrast to self-control, impulsivity occurs when time gets closer to reinforcement, where the value of the smaller impulsive option is more preferred than the larger reward (Ainslie, 1975; Ainslie, 1994; 1995; Monterosso and Ainslie, 1999). Accordingly, the organism experiences immediate gratification at the expense of the delayed (and more valuable) outcome (Mazur, 1997; Mischel & Ebbeson, 1970). Further, Rohsenow, Monti, Rubonis, Sirota, Niaura, Colby, Wunschel, and Abrams, (1994) suggested that impulsivity is associated with dependence and addiction pathologies in humans.

A fundamental question for any operant theory concerns its applicability to human behaviour (Nevin & Grace, 2000). To support this proposition, there has been a growing body of evidence on self-control in animal and human research (Mischel and Ebbeson, 1970; Rachlin & Green, 1972; Grosch and Neuringer, 1981; Schweitzer & Sulzer-Azaroff, 1988; Chavarro & Logue, 1988; Siegel and Rachlin, 1995; Logue, 1996; Mazur, 1998; Chelonis, Logue, Sheehy & Mao, 1998; Grace, 1999). Moreover, one advantage of self-control research is that it demonstrates how operant laboratory procedures of self-control can mirror real world situations (Mazur, 1998; Chelonis, Logue, Sheehy & Mao, 1998; Logue, 2002).

Two sources of research show that self-control occurs between humans and non-humans. The first experiments were conducted with children in the "delay of gratification paradigm" (Mischel and Ebbeson, 1970). The other is a comprehensive study where pigeons were exposed to a series of Mischel's delay of gratification paradigm experiments (Grosch and Neuringer, 1981). Findings from both studies are comparable and provide empirical evidence that self-control phenomena are similar for humans and non-humans.

In Mischel and Ebbeson's (1970) "delay of gratification paradigm", pre-school aged children were left alone in a room in different conditions. One condition was when children were in the presence of rewards; a pretzel (the immediate reward) and a animal cracker (the larger delayed reward). The other condition consisted of where the children were initially shown the same rewards and then they were removed from their view. Thus, the study examined the children's preferences for the various rewards in a waiting situation. For instance if the child rang the bell prior to the experimenter returning they received the immediate reward (i.e., showing impulsivity). However if they did not ring the bell and thus waited for the experimenter to return they would receive the longer delayed reward (i.e., showing self-control). The children were systematically trained on procedures and would repeat instructions back to the experimenter to show that they could carry out the experimental tasks.

Mischel and Ebbeson (1970) found when rewards were shown to the children, then removed from their view waiting time increased (i.e., the criterion waiting time of 15 minutes). Consequently, the children received the animal cracker. These

findings concluded that in this condition the children showed self-control behaviours. On the other hand, exposure to immediate and delayed rewards decreased the children's waiting time (on average this time was two minutes before ringing the bell). Thus, the children received the pretzel. As a result, the children showed impulsive behaviours. In another study self-control behaviour increased when the children were engaged in another activity whilst in the waiting condition (Mischel, Ebbesen and Zeis, 1972).

Mischel's delay of gratification findings applies as well to animal findings on self-control. Grosch and Neuringer (1981) sought to replicate Mischel's findings with pigeons. The main question was whether animal and human self-control have analogous characteristics and whether both are influenced by similar variables. They proceeded to answer this question in a number of studies by manipulating reinforcer, delay and saliency of stimuli (e.g., food presentation, flashing lights and lit and darkened hoppers).

In Grosch and Neuringer's (1981) first study, pigeons were exposed and not exposed to food reinforcers throughout the waiting period. Illuminated hoppers for the SS or LL reinforcers represented exposure to the reinforcers. Darkened hoppers however were employed for the absent reinforcers. Findings from this study were comparable to those of the Mischel studies where the pigeons showed self-control and waited longer when the reinforcers were absent. Conversely, when the pigeons were exposed to the food reinforcer they chose the less-preferred food and did not wait as long.

In another experiment, the authors examined the effects of pigeons engaging themselves in another activity during the delay time whilst waiting for the LL reinforcer. This experiment was based on Mischel, Ebbesen and Zeiss, (1972) study where the investigators hypothesised that redirecting children's attention on the rewards might increase self-control. In this study one group of children were given a toy to play with whilst another group of children did not receive the toy. Their hypothesis was confirmed where children who received the toy waited longer and thus increased their self-control.

Grosch and Neuringer (1981) investigated whether analogous results could be obtained with non-humans. Pigeons were trained to peck a rear key (this rear key replaced the toy) opposite the two keys used in the self-control experiment. After training, this new alternative was increased to a Fixed Ratio 20 (FR 20) programmed to deliver 75 reinforcements. The experiment consisted of three procedures. The "no toy" procedure was where the rear key was concealed and where self-control procedures as described in Experiment 1 were conducted. In the second procedure, the pigeons were exposed to a "toy plus FR 20 condition". The rear key was operable during the wait interval. The 20^{th} peck was reinforced with the pigeon obtaining a food pellet. The third procedure was similar to the "toy plus FR 20 condition" except pecks on the rear key produced no pellets as reinforcements. The results showed that the pigeons found it easier to wait for the preferred reinforcer when pecking on the rear key took place during the waiting time. Therefore, this finding was similar to Mischel's study in which childrens' waiting time increased whilst they were pre-occupied with a toy in the waiting interval.

A further study was conducted to test the self-control procedure shown in Mischel, Ebbesen and Zeiss (1972) study. One group of children were instructed to think about the rewards and another group were instructed not to think about the rewards. Mischel et al (1972) found that the children's thinking about the rewards decreased the waiting time to receiving the rewards. These findings were similar to previous results where the visibility of rewards during the waiting time decreased preference for the larger preferred reward. However not thinking about the rewards increased waiting times. Instead of using cognitive strategies with the pigeons, illumination of conditioned stimuli (the food hopper) was associated with rewards. Therefore, unlike Experiment 1 where the food hopper trials were illuminated the hopper did not become activated. If the pigeon placed its head in the hopper, a 20-s inter-trial duration (black out) occurred. Other trials in the waiting time did not use the illuminated hopper.

Obtained results showed that the pigeons waited less when the hoppers were illuminated than when they were dark. These findings are consistent with Mischel et al. (1972) findings when the children were exposed to the food rewards. However, Grosch and Neuringer (1981) proposed that the hopper lights might have affected performance because the birds were associating the lights with reinforcers. For instance, visible food in the illuminated hopper might have been associated with a positive stimulus. Conversely, when the inter-trial interval occurred this might have been associated with a negative stimulus. Thus, it remained unclear whether this procedure would have detected self-control or impulsivity amongst the pigeons.

To minimise the possible confound another experiment used a flashing overhead light to signal the positive stimulus and another flashing overhead light served as the

negative stimulus during waiting times. Grosch and Neuringer (1981) predicted that the positive stimulus during the waiting interval would prompt self-control. Effects of the positive and negative stimuli were examined separately. These results were found to be inconsistent with the previous experiment. In that study, it was shown that when the hoppers were lit during the waiting time self-control diminished. However in the present case when the flashing overhead lights preceded availability to reinforcement self-control increased. Grosch and Neuringer, (1981) concluded that different contingencies may have contributed to the differences in the results.

In summary, human and non-human self-control findings were found to be analogous and comparable. For example when the reinforcers were present the pigeons and children's waiting time decreased. These experiments showed that there was a higher preference for the SS outcome. This behaviour was exhibited as impulsive behaviour. However, when the reinforcers were absent the pigeon's and children's waiting time increased. Therefore, these experiments showed that there was a higher preference for the LL outcome. When the children and pigeon's were occupied in an activity during the delay interval this procedure increased waiting times. Based on the comparative findings across these human and non-human studies the role of self-control paralleled largely.

The next section reviews the area of commitment, which is a subset of self-control. This topic will help to elaborate self-control procedures and further findings that have been undertaken in the operant laboratory.

Commitment

Ongoing research has highlighted and provided an increase in specificity and importance to the area of self-control. Such specificity refers to the "commitment" paradigm (Rachlin and Green, 1972). This section will review findings of basic experiments that support commitment. Of particular interest, preference reversals will be discussed in relation to commitment (Rachlin and Green, 1972).

Commitment (or strict commitment) is the emission of some response now that eliminates a future impulsive option and only allows the choice of the self-control option (Rachlin and Green, 1972; Rachlin, 2000). For example, consider an individual who is undertaking alcohol rehabilitation has their hands tied up (commitment response) to refrain from drinking alcohol. In animal experiments, commitment is shown when the pigeon responds on a key that prevents an upcoming choice between LL and SS reinforcers and ensures that the LL reinforcer is obtained.

In a seminal paper, Rachlin and Green (1972) conducted a commitment experiment with pigeons. First, a white light illuminated the choice keys (the initial link). Entry to the next link resulted in the pigeon being exposed to a Fixed Ratio 25 (FR 25) schedule. 25 responses could be distributed in any order on the two alternatives. If the pigeon's 25^{th} peck was on the right key the houselights were darkened and then two alternative keys were lit for the pigeon to make a choice. One peck on one key would lead to obtaining the SS outcome (2-s of available food followed by a 6-s black out) or the LL alternative (4-s black out followed by a 4-s available food). Following the reinforcement or black-out the white light which illuminated the choice keys re-appeared. This indicated that a new trial was ready to

commence. However if the 25th peck in the initial link was made on the left key a black-out (i.e., the black-out interval varied between sessions but remained constant within one session) occurred followed by the presentation of only one lit key. The other key remained inactive. A single peck on the lit key led to the pigeon obtaining 4-s of available food after a 4-s black-out.

Findings revealed when the pigeons chose the right key on the 25th response a stronger preference for the SS reinforcer was shown in the initial link. This was due to the overall rate of the SS outcome was half of the LL outcome, where the pigeons lost half of the food in exchange for 4-s less delay between choice and reinforcement. Thus, the pigeons showed preferences for the impulsive outcome. However when the 25th peck was made on the left key in the initial link to where the black-out interval increased from 0.5-s to 16-s, four out of the five pigeons more frequently committed themselves to obtaining the LL outcome.

Commitment can be quantified by a reversal of preference as the delay of choice alternatives changes (Rachlin and Green, 1972). Rachlin and Green's study used one form of the matching law to predict preference reversal to demonstrate commitment (Baum and Rachlin, 1969). Baum and Rachlin explained that preference reversals can be predicted when delays and magnitudes are multiplied according to Equation 2. For example, let's assume that the ratios M_L to M_R equalled 2. If D_R = 1-s, and D_L = 5-s then $\frac{M_L}{M_R} * \frac{D_R}{D_L} = 2 * \frac{1}{5} = \frac{2}{5}$ which shows preference for the SS reinforcer. Now if 10-s is added to the delays to both outcomes, $\frac{M_L}{M_R} * \frac{D_R}{D_L} = 2 * \frac{11}{15} = \frac{22}{15} = 1.47.$ Therefore, this prediction of the matching law indicates a stronger preference for the LL

reinforcer. Similarly, when the blackout interval increased in the left key, the matching formula predicted a shift in preference from the SS to the LL outcome (Rachlin and Green, 1972). Another model that predicts the preference reversal is the hyperbolic decay and hyperbolic addition models (see Mazur, 1987; 2001 for review).

In Rachlin and Green's study, the subject switches to choosing the other alternative at a certain point in time. For example, we would expect as time to reinforcement grows shorter (while the 25 responses are made in the FR 25) the key that leads to the SS outcome should be preferred (Rachlin and Green, 1972). However, as the blackout interval increased and the delay of SS and LL outcomes increased the pigeons preferred the LL to the SS outcome (Green and Rachlin, 1972). Therefore, preference in this study for commitment varied directly with the delay (see Figure 1).

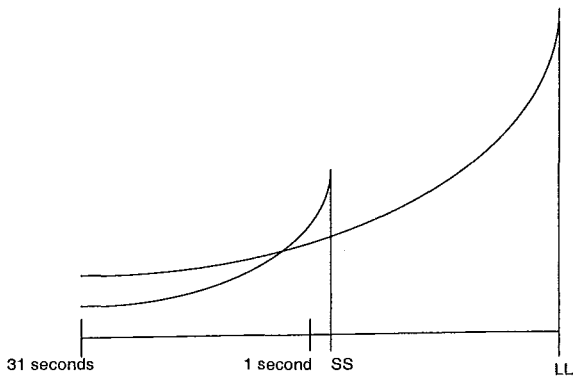


Figure 1: How the value of the SS or LL outcome changes as a function of delay until receipt of the outcome.

Green and Rachlin, (1996) conducted another study on commitment with pigeons by investigating the effects of punishment (e.g., a black out associated after immediate delivery of a SS food reinforcer). A concurrent chains procedure was used to evaluate the pigeons preference for the SS, LL, and shorter-sooner with punishment (SSP) outcomes (the values for these outcomes varied for each pigeon). Delay from the initial link and terminal link was varied across conditions. One terminal link presented a choice between the SS and the LL. The other terminal link offered a choice between the LL and SSP outcomes. In the initial link both alternatives were lit with white light. Passage to the terminal link was on Fixed Ratio 3 (FR 3) schedules. Three responses on one initial link key led to the keys darkening followed by two keys that became illuminated. One peck on either of the two keys led to SS or LL reinforcement. This alternative was referred to as the unpunished condition. However, three responses on the other initial link key led to the keys darkening but the house light remained on. Then the two keys became illuminated. A peck on one key led to the SSP outcome, whereas a peck on the other key led to obtaining the LL outcome.

Results yielded a stronger preference for the SS reinforcer when pigeons chose the unpunished terminal link. However, as delay increased response rate decreased from the unpunished terminal link. As a result, the authors found that LL preference increased after black out time in the punished terminal link had increased. With the exception of using a different procedure (e.g., use of a punished terminal link) these results were consistent with findings by (Rachlin and Green, 1972). In particular, the only way in which pigeons could obtain the LL outcome was through an increased black out interval in the terminal link. Pigeons from both studies chose the black out interval more frequently as delay to both reinforcers increased. Obtaining the LL outcome could be predicted from Equation 2 (Baum and Rachlin, 1969).

One possible limitation of commitment is that it would be difficult to apply in a clinically applied context. For instance, it would be foolish to wire an individual's jaw shut to help them lose weight (Siegel and Rachlin, 1995). Logistics of this treatment programme would definitely contravene ethical standards (New Zealand Psychological Society, 2002). Furthermore problems arise when the restraint is removed, the maladaptive behaviour (e.g., eating excessive amounts of food) is likely to return (Siegel and Rachlin, 1995).

However, unlike strict commitment, commitment-using punishment does correlate to many human self-control procedures (Rachlin, 2000). For example, when one enters into a marriage, penalties such as divorce might take place as a result of matrimonial disharmony (Rachlin, 2000). Alternatively, when one does not obey the rules of the law they could be subjected to incarceration or heavy fines.

Further research in the next section show extended developments of commitment in the context of soft commitment.

Soft Commitment

Much research attention has focused on ways in which self-control can be enhanced, such as the "delay of gratification paradigm" (Mischel and Ebbeson, 1970; Grosch and Neuringer, 1981), the commitment paradigm (Rachlin and Green, 1972; Green and Rachlin, 1996) and recently the "soft commitment paradigm" (Siegel and Rachlin, 1995). This section provides a description of soft commitment and in particular, we will review the soft commitment findings and outcomes (Siegel and Rachlin, 1995).

Soft commitment is based on a conception of self -control as a long-term temporal pattern (Rachlin, 1995; Rachlin, 2000). Temporal patterning refers to the fact that behaviour unfolds in time. Because patterns take time to occur Equation 2 predicts preference to change from LL to SS. Once the pattern commences it becomes costly to interrupt, the further the pattern proceeds in time, the more costly it is to interrupt (Siegel and Rachlin, 1995; Rachlin, 1995; Rachlin, 2000). Nonetheless, soft commitment depends on a cost due to pattern interruption. However, disregarding this cost would result in the pigeons pecking on the LL key but switching to the SS key at a certain point in time and obtaining the SS outcome (see Figure 1 and discussion on preference reversals in the commitment section). Unlike the commitment paradigm, in Siegel and Rachlin (1995) study preference for LL could be reversed at anytime during the experimental trials.

One who is on a fitness programme might exemplify an analogous human situation of soft commitment. They may forfeit two days of training (the pattern interruption) thus indulging in having extra helpings of Pavlova (which involves a cost

of becoming overweight). The cost does not address health because it is abstract and has no point of onset. Rather the cost focuses on the interruption itself (having the extra dessert) in where it occurs at a particular point in time of the fitness-training regime (Rachlin, 2000). This cost is enough to overwhelm the SS outcome and for this reason, the individual switches back to obtaining the LL outcome (leading a healthy regime and lifestyle).

Siegel and Rachlin (1995) studied soft commitment patterning in the laboratory with pigeons. In all conditions one of the alternatives led to obtaining a SS outcome (e.g., 2.5-s access to wheat grain that was accessible after a 0.5-s delay). The other alternative led to obtaining a LL outcome (e.g., 4 seconds access to food that was made available after a 4-s delay). Unlike strict commitment where the pigeons chose the commitment outcome they could only obtain the LL outcome only, the pigeons in the present study were permitted to switch between the choice alternatives in all conditions.

Results in Siegel and Rachlin's study found that in the CRF condition overall there was 95% preference for the SS outcome.

In the FR 31 condition, each trial involved delivery of a SS or a LL reinforcer after every 31 responses. Which outcome was produced depended on the alternative chosen on the 31st response. Results obtained in this condition revealed 64 % preference for the LL reinforcer on the 31st response. Despite opportunities to switch to the SS alternative once the pigeons started to peck on the LL alternative they refrained from switching to pecking on the SS alternative. These findings

demonstrated that soft commitment was found in the FR 30 condition (Siegel and Rachlin, 1995; Rachlin, 2000).

The Fixed Interval 30 (FI 30) condition was used to identify whether soft commitment would weaken with interval rather than ratio schedules. Unlike the FR 31 schedules, FI 30 schedules do not require a 31 peck-contingency to obtain reinforcement. Instead, the first peck on one of the alternatives after the interval has elapsed leads to obtaining the SS or LL reinforcement (Mazur, 1998). Previous research on FI schedules has shown that scalloped patterns of rapid responding increases towards the end of the interval (Catania, 1969; Mazur, 1998). According to preference reversals, (see Figure 1) as time gets closer to obtaining reinforcement preference for the SS may be stronger. Evidence of this was shown when on average results showed an increase in preference for the SS outcome as the FI 30-s schedule elapsed.

In summary, findings gleaned from this study showed that soft commitment was present in the FR 31 condition. On the other hand impulsive behaviour was strongly shown in the CRF condition. The investigators reported one limitation, which might have precluded the generality of these findings. They reported that the potential of order effects might have occurred between the different conditions. Thus, the question remained whether or not soft commitment was shown in the FR 31 condition or not. Therefore, further research in soft commitment is required. In the next section, further discussion is made on the clinical area of temptation and its potential function in soft commitment.

Temptation

"First of all, the children are urged to examine their own behaviour while looking at the lollipops. This helps them to recognize the need for self control."

B.F. Skinner, Walden Two, p 98.

The purpose of this second study was to develop a preliminary model for temptation with non-humans. Furthermore, we examined whether pigeons were able to persist responding that led to obtaining the more preferred outcome (e.g., the LL reinforcer) despite the occurrence of a "temptation" stimulus. Rachlin (1995) contended that this extended response patterning might be conceptualised as soft commitment. Similarly, opportunities to yield to temptation may occur frequently for humans engaged in a pattern of soft commitment. Therefore, we will attempt to provide a plausible explanation of temptation with non-humans and discuss its applicability to clinical populations and soft commitment.

Temptation in non-humans and humans can be categorised in three ways. Firstly, it can be an additional competing impulsive choice that is pitted against two concurrent choices, which is the SS or the LL reinforcer (Ishii & Sakagami, 2002). Secondly, temptation can be seen as a mediating variable that influences whether the organism deviates from obtaining a LL outcome by switching to the SS outcome (Trope and Fishbash, 2000). This switch however may quickly return to the preferred pattern of behaviour to obtain LL reinforcement (Trope and Fishbash, 2000). Thirdly,

temptation can be construed as a deviation from the preferred pattern of behaviour to the impulsive choice without a subsequent return (Prochasky and Diclemente, 1992). There are many descriptions of temptation but for the purpose of the present research these three shall suffice.

There are several reasons why temptation is interesting to examine within non-human and human subjects. First, many temptation situations naturally occur in an animal and human ecological context (Fisher and Mazur, 1997). Second, temptation in a clinical context is an important construct for theories and treatment on addictions and dependence problems (Prochaska and DiClemente, 1982). Research in the clinical field claimed that temptation maybe seen as a mediating variable that influences whether the individual takes action, maintains any successful behavioural change or relapses into previous risk behaviour (Prochaska, DiClemente and Norcross, 1992).

Such claims have highlighted the potential efficacy of cue exposure treatments conducted with alcohol dependent populations (Drummond and Glautier, 1994). In one series of experiments, participants underwent repeated exposure to pre-ingestion of alcohol (the smell of a glass of beer) without consuming the alcohol (Drummond and Glautier, 1994). The researchers hypothesised that this repeated exposure would lead to extinction of Pavlovian conditioned responses thus reducing the likelihood of relapse to drug taking behaviour. Findings showed that the prevalence rate in the cue exposure group improved in overall latency to resume drinking and dependence compared to the control group. Initial relapse rates also favoured the cue exposure group relative to the control group, although results failed to attain statistical significance (Drummond and Glautier, 1994).

Several studies have yielded similar findings regarding the efficacy of cue exposure therapies in the treatment of alcohol dependence. For example, the client is taught to attend to eliciting stimuli and to their elicited responses to the cues, this enables them to resist the temptation of drinking (Rohsenow, Monti, Rubonis, Sirota, Niaura, Colby, Wunschel and Abrams, 1994). The results of cue exposure treatment for nicotine and heroin dependence however have not been supported (Dawe, Powell, Richards, Gossop, Marks, Strang and Gray, 1993).

Another study taken from a human laboratory showed that participants were given a primary dose of the drug (e.g., alcohol) and then were encouraged to resist the temptation to consume more of the available drug (Rankin, Hodgson and Stockwell, 1983). This procedure, called the "prime dosing prevention treatment", was expected to enhance self-control of drug behaviour rather than maintain abstinence. The researchers claimed that this approach was similar to that of cue exposure to obsessive-compulsive pathologies. Results revealed that initially participants yielded to having a drink but towards the end of the experiment drinking behaviour decreased in the laboratory context. However, there was no evidence that the effectiveness of the procedure was generalised in a clinical follow up or a natural drinking environment study (Rankin, Hodgson and Stockwell, 1983).

Another way to resist temptation is to adapt a pre-commitment approach. Behavioural resistance to temptation might be exemplified when the organism is able to pre-commit to a set course of action prior to being exposed to tempting forces. For example, instead of deviating from one's diet and being tempted to eat a copious amount of fattening foods, a weight-conscious individual may pre-empt temptation by

going to a restaurant where their favourite unhealthy dish is not available (Ariely and Wertenbroch, 2002).

Similarly, in the non-human context, studies have shown that pigeons were able to commit at the beginning of an experimental trial to obtaining the LL reinforcer (Rachlin and Green, 1972; Siegel and Rachlin, 1995). Consequently, the pigeon's persistent responding patterns in the FR schedules led to access of the longer delayed more preferred reinforcer (Rachlin and Green, 1972; Siegel and Rachlin, 1995; Green and Rachlin, 1996).

Therefore, in the second study to extend and test the soft commitment responding where switching can occur between alternatives we measured the effects of when a temptation cue was introduced in the FR 31 trials. Soft commitment was shown to take place in the FR 31 trials thus the reason of using the FR 31 trial for the present study. In particular, the temptation cue was presented at designated response locations of the FR 31. Reasons for doing such a procedure were to investigate whether or not the subjects would yield or show resistance to the temptation cue at different points of the FR trial. As a result, this study provides preliminary research for further experimental investigations.

The Current Study

The first objective of the present research sought to replicate Siegel and Rachlin's (1995) claims concerning FR response patterning which was strongly associated with soft commitment. However the authors reported that order of presentation of the conditions were not counterbalanced. Accordingly, the significant differences between conditions may have been due to a number of reasons thus confounding the clarity of their findings.

Therefore, in the first experiment a counterbalanced ABA (e.g., FR 31 – FI 30 – FR 30) design was introduced to minimise possible order effects between conditions. As a result, this design would provide further evidence for whether or not FR 31 schedules supported a greater degree of soft commitment compared to the FI 30 schedules

Given the previous findings from self-control, commitment and soft commitment it is surprising that no study has yet directly compared the effects of temptation within these paradigms. To address the gap the second objective of the present study investigated the effects of an introduced temptation manipulation in FR 31 trials. These trials were used because Siegel and Rachlin (1995) findings revealed that soft commitment was shown in this condition. Of particular interest, examination of temptation effects might challenge soft commitment.

METHOD

EXPERIMENT 1

Subjects

Four pigeons were maintained at approximately 85% of their free-feeding weights by post session feedings. A 12-hour light on / off cycle was in effect during the day. All subjects had prior experience with a variety of experimental procedures. The pigeons were housed in individual cages in an internal vivarium. Heating temperatures in the vivarium ranged between 19-21 degrees. Water and grit were continuously available in their individual home cages. Sessions were run at approximately the same time on a daily basis.

Apparatus

Experimental sessions were conducted in four identical experimental chambers measuring 55 cm wide by 40 cm high. Three response keys were mounted on the front panel of each chamber. Each key required a 0.15N force which produced a feedback click when it was pecked. Each key was green, yellow or red when illuminated. The panel also contained a house light located above the three keys. A food hopper situated below these keys was used to deliver the food reinforcement of wheat grain. During reinforcement, the hopper was illuminated with white light and was elevated to allow access to the wheat. During experimental sessions, fans attached to each chamber provided ventilation and concealed extraneous noises. An IBM – compatible Personal Computer (PC) using Med PC programming software, located in an adjoining room recorded all responses. In addition, an infrared camera was located in

each chamber. Observations of the bird's behaviours during the sessions were viewed from an attached television monitor.

Procedure

Initially all of the birds received preliminary training with exposure to the stimulus that was later to be used for the "temptation" cue. This procedure involved an illuminated centre red key light. When this key was pecked a 0.5-s delay followed by immediate delivery of 2.5 seconds (s) access to grain was delivered (this is the same procedures and magnitude used for the shorter sooner SS food reinforcement outcome). During the delivery of the food reinforcer the hopper light was lit. Preliminary training with the temptation cue continued for five sessions. An intertrial interval of 30-s followed each temptation cue, during which the operant chamber was dark. The preliminary session consisted of 45 trials. Thereafter the temptation preliminary training concluded.

Following preliminary training with the temptation stimulus subjects were exposed a procedure with 12 forced choice trials and 45 free choice trials. The forced choice (e.g., only one key was lit and functioning) trials (six shorter-sooner and six longer larger outcomes in random order) preceded the free choice or experimental trials. The shorter sooner (SS) reinforcers consisted of a 2.5-s of reinforcer delivery that followed a 0.5-s black out delay (also known as the terminal link). The other was the longer larger (LL) reinforcer, which was a 4-s delivery of reinforcer delivery that followed a 4-s black out duration. A 5-s black out immediately followed the SS reinforcer to ensure that trial duration was the same as obtaining LL reinforcement.

The forced choice procedure was designed to make certain that the subjects would sample both alternatives and to weaken position preferences.

For the present study an ABA design (e.g., FR 31 – FI 30 – FR 31 experimental trials) was used to prevent potential order effects (refer to Table 1). This was a methodological limitation reported from Siegel and Rachlin's (1995) study.

Another reason for using this type of design was to evaluate whether soft commitment was enhanced by the response patterns associated with the FR 31 condition. This was determined by comparing the preference of the SS outcome in the Continuous Reinforcement Schedule (CRF) to the Fixed Ratio 31 (FR 31) condition. Furthermore, these comparisons were pitted against the preference of the SS outcome in the CRF and Fixed Interval 30 (FI 30) conditions. This was to assess whether soft commitment or impulsivity was shown in the comparisons.

Therefore, when preliminary training and forced choice trials were terminated, subjects were exposed to the baseline condition namely the CRF condition. In the initial link, subjects were presented with green and yellow side keys. The spatial location (left / right) of green and yellow keys from side to side varied pseudo-randomly from trial to trial. The subjects chose between the SS and LL reinforcer by one response emitted on either key. Then both key lights were darkened and the hopper light was lit when subjects received the corresponding outcome to the pecking response (2.5-s or 4-s food delivery). After each outcome had been obtained a 30-s inter-trial-interval (ITI) began.

For two subjects, the green key was associated with the shorter-sooner (SS) food reinforcement. For the same two subjects the yellow key was associated with the larger longer (LL) food reinforcement. For the other two subjects, the key colour assignments were reversed. In this condition, a session concluded after 45 experimental trials. When each of the other experimental conditions had terminated, return back to this baseline condition re-commenced (see Table 1).

In the second condition FR 31 schedules were used. In this condition, the pigeons needed to complete 31 responses on either alternative before an outcome was obtained. As a result, the 31st response on either key led to the pigeon obtaining the SS or the LL reinforcer. Reinforcement magnitude and delay for either key was the same as seen in the CRF condition. However, this condition differed from the first condition, as there was not an inter-trial interval (ITI) phase between each trial and that 31 responses versus 1 response were required to obtain reinforcement. For subject B4 initial inspection the data indicated that there was no soft commitment shown in the first two conditions. Therefore a colour reversal of keys were changed and return to baseline procedure was used to reduce possible side preference for this subject (see Table 1).

In the third condition, return back to the CRF condition was designated for all subjects.

In the fourth condition, a Fixed Interval 30 (FI 30) was used to compare against the FR 31 condition. An FI trial involved an interval where both key lights were lit for 30-s where the subject was able to respond on either key. The first response after 30-s

had elapsed determined either the SS or LL reinforcement. Reinforcement magnitude and delay for either key was the same as seen in the CRF and FR 31 conditions.

The fifth condition was a reinstatement of the CRF condition.

Finally, in the sixth condition a return to the FR 31 condition was employed to complete the ABA design.

After this final FR 31 condition, subject B3 recaptured baseline by returning back to CRF and then completed the FR 31 condition (see Table 1). However, the data for the extra last two conditions for this subject was not shown in the results section as this subject had fulfilled requirements for the ABA design. Additionally subject B4 failed to complete the second FR 31 as responding ceased for this subject.

Table 1: Conditions used in Experiment 1.

Conditions	Subject	Number of Sessions	Number of Trials
Continuous Reinforcement Schedule **(CRF)**	B 4	26	45
Fixed Ratio 31 **(FR31)**	B 4	17	45
CRF	B 1	26	45
	B 2	26	
	B 3	26	
	B 4	25	
FR31	B 1	40	45
	B 2	40	
	B 3	27	
	B 4	15	
CRF	B 1	16	45
	B 2	16	
	B 3	15	
	B 4	28	
Fixed Interval 30 **(FI 30)**	B 1	28	45
	B 2	35	
	B 3	16	
	B 4	40	
CRF	B 1	16	45
	B 2	16	
	B 3	28	
	B 4	21	
FR 31a	B 1	40	45
	B 2	33	
	B 3	28	
CRF	B 3	26	45
FR 31b	B 3	31	45

To determine the change of conditions, Siegel and Rachlin's (1995) stability criterion was used. That is, a condition ran for at least 15 sessions and no more than 40 sessions, and was changed when a preference was shown for either alternative for five consecutive sessions. "Preference" was defined as deviating from 50% in either direction. However, in some cases, if there appeared to be a systematic trend in preference, conditions were continued for additional sessions after Siegel and Rachlin's criterion had been satisfied.

RESULTS

The primary data analysed for individual subjects were the means derived from the last five sessions of each condition. Table 2 lists the preference for the SS outcome for all subjects and conditions.

Table 2: Aggregated means taken from the last 5 sessions for each subject indicating percentage of preference for the SS reinforcer

	B 1				**B 2**			
Condition	Sessions. Siegel & Rachlin (S & R) Criterion.	Preference for SS reinforcer	Total Sessions (Visual Criterion)	Preference for SS reinforcer	Sessions (S & R Criterion)	Preference for SS reinforcer	Total Sessions (Visual Criterion)	Preference for SS reinforcer
CRF	26	.87			26	1.00		
FR 31	34	.40	41	.44	40	.38	41	.38
CRF	16	.82			16	.99		
FI 30	15	.64	28	.68	35	.60		
CRF	16	.90			16	.91		
FR 31	40	.52	41	.52	33	.13		

	B 3				**B 4**			
Condition	Sessions (S & R Criterion)	Preference for SS reinforcer	Total Sessions (Visual Criterion)	Preference for SS reinforcer	Sessions (S & R Criterion)	Preference for SS reinforcer	Total Sessions (Visual Criterion)	Preference for SS reinforcer
CRF	26	.99			25	.60		
FR 31	22	.37	28	.40	16	.19		
CRF	14	.98			28	.59		
FI 30	16	.38			40	.87		
CRF	28	.97						
FR 31	28	.59						

It appeared that Siegel and Rachlin's stability criterion was quite flexible and liberal because of the range where preference could be met between 15 – 40 sessions. When the Siegel and Rachlin criterion was satisfied, the condition was potentially terminated. However if there appeared to be a visual trend for preference for either alternative, training continued past the Siegel and Rachlin criterion requirement until an asymptote level was reached by visual assessment.

Moreover, we wanted to compare preference using the visual stability criterion for those conditions in which sessions continued with preference obtained using Siegel and Rachlin's criterion (see Table 2). Although in one case the stability criterion had been satisfied up to thirteen sessions prior to changing conditions, the visual analysis calculated the means of the actual last 5 sessions in each condition.

As shown in Table 2, preference did not change systematically when conditions continued for additional sessions after the Siegel and Rachlin criterion were satisfied. Results from the visual analysis showed that the preference of the SS outcome in different conditions increased by 4%, 4%, 0%, 0% and 3%. When these preferences were averaged, the visual analysis compared to the Siegel and Rachlin criterion was 2.2%. This visual inspection of the results appeared to be consistent with findings in using the Siegel and Rachlin (1995) criteria thus supporting the validity of Siegel and Rachlin's stability criterion (depicted in Table 2). Thus, Siegel and Rachlin's criterion was adequate to ensure that preference was stable.

Figure 2 presents the mean percentage of preference for SS reinforcers in each condition for each subject. For subjects B1-3, there were no systematic differences in preference across the CRF determinations. For instance, in the CRF condition, responding during the initial link showed almost exclusive choice of the SS outcome for subjects B1, B2 and B3. When presented with the SS and LL alternatives, preference data found across the three subjects was 94 % for SS over the LL reinforcer. However, the other subject B4 stopped responding during the second FR 31 condition and thus the CRF, FR 31 and FI 30 data for this subject was recorded from the first determination only. Therefore, subject B4 showed a mean preference of 60 % for the SS over the LL outcome for two out of the three CRF conditions.

Preference of the SS reinforcer was averaged between both FR 31 conditions for subjects B1 and B3 in which 48% and 48% preference were respectively found. Notably for subject B2 the mean preference of the SS reinforcer for both FR 31 conditions was 29%. For subject B4, preference in the one FR 31 condition for the SS over the LL outcome was 19%.

The mean SS preferences in the FI 30 condition were 68%, 60%, 38% and 87% for subjects B1 through to B4 respectively.

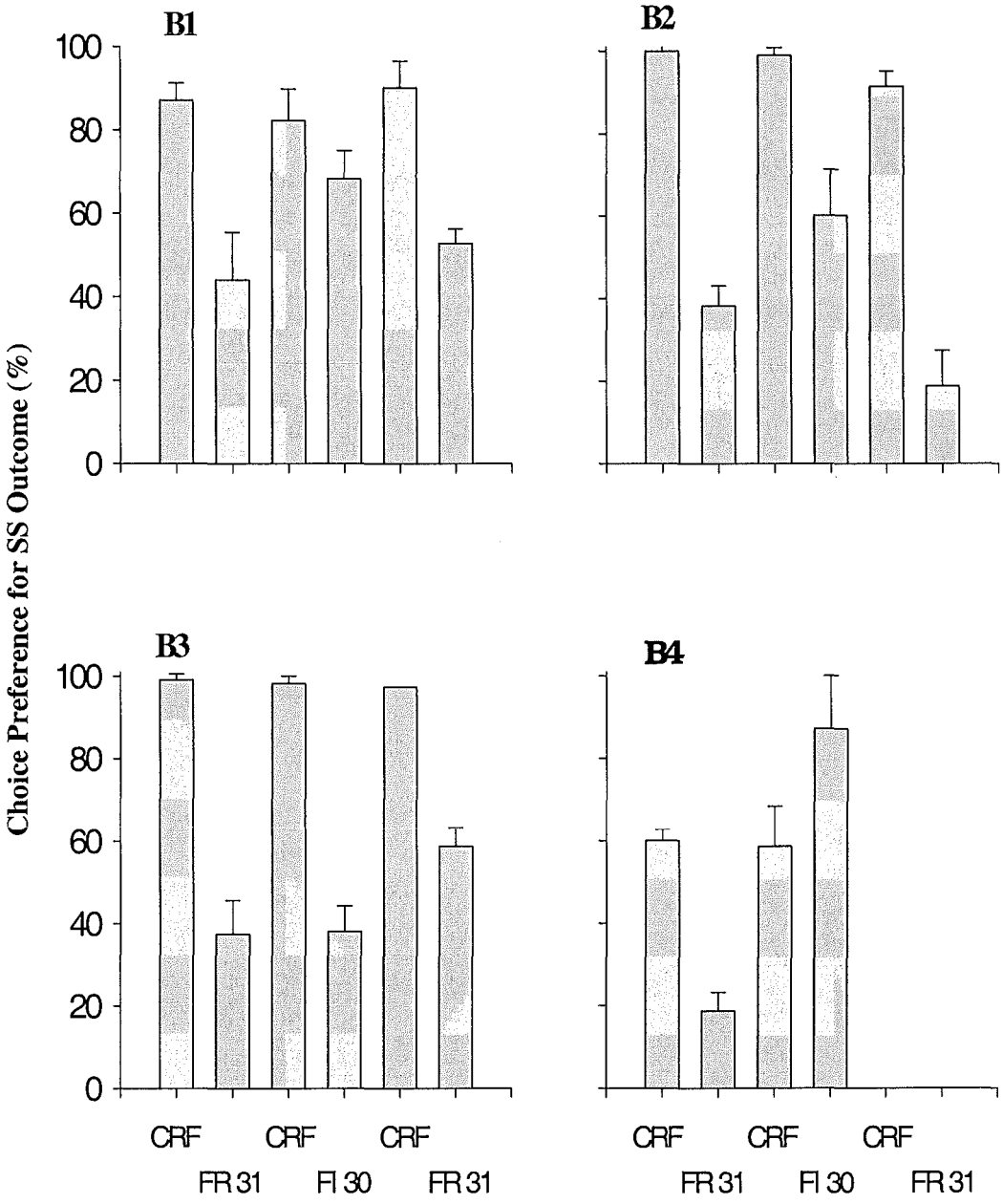


Figure 2: Individual subject's data for preference of the SS reinforcement. The error bars show the standard deviation across the last 5 sessions in each condition.

Several analyses were calculated to determine whether soft commitment was obtained in the two experimental conditions (FR 31 and FI 30), and the magnitude of any soft commitment effect.

First, a one-way repeated measures Analysis of Variance (ANOVA) analysis was conducted to test for significant differences across conditions. Data for the multiple determinations of each condition were averaged for each subject for this analysis. The ANOVA found a significant main effect of condition, $F\ (2, 6) = 6.18$, $p < .05$. This indicated that there was a significant difference or differences across conditions.

Planned Comparisons were conducted to determine whether soft commitment (defined as a significant decrease in preference for the SS alternative between the CRF and either FR 31 or FI 30 conditions) was obtained in the FR31 and the FI 30 conditions. For the FR 31 and CRF conditions, the comparison was significant, $F\ (1, 3) = 44.36$, $p < 0.01$. However, the comparison failed to reach significance between the FI 30 and CRF conditions, $F\ (1,3) = 3.14$, *ns*. This suggests that soft commitment was performed consistently in the FR 31 condition, but not in the FI 30 condition.

A second analysis required the preferences across conditions for individual subjects. Figures 3 and 4 show the mean percentages of SS preference as a function of comparison between the CRF condition and the FR 31 and FI 30 conditions. A 'shift analysis' was used in which the magnitude of the soft commitment effect was completed as the change in preference for the LL outcome between the CRF and either FR 31 or FI 30 conditions.

For subject B1, preference for the SS outcome in the first CRF and for the first FR 31 condition was 87% and 44% respectively. In the second CRF condition, preference for the SS outcome was 82% and for the FI 30 condition, preference for the SS outcome was 68%. Preference for the SS outcome in the third CRF was 90% and in the second FR 31 condition, preference was 52%. Therefore, for this subject, soft commitment was shown in the first FR 31 and second FR 31 condition, which revealed a 43% and 38% shift. This shift for both FR 31 conditions showed a mean preference for the LL outcome of 52%. For the FI 30 condition, there was a shift of 14%. Thus, subject B1 showed soft commitment in all conditions but the magnitude was greater in the FR 31 conditions.

The mean preference for the SS outcome for subject B2, in the first CRF condition was 100% and for the first FR 31 condition was 38%. In the second CRF and FI 30 conditions preference for the SS outcome was 99% and 60% respectively. In the third CRF and second FR 31 condition preference was shown at 91% and 13% respectively. For this subject soft commitment was clearly demonstrated in both FR 31 conditions. Specifically, results revealed a 62% and 72% shift. This shift for both FR 31 conditions showed a mean preference for the LL outcome of 71%. For the FI 30 condition there was a shift of 39%. Thus, subject B2 showed soft commitment in all conditions but the magnitude was greater in the FR 31 conditions.

The averaged preference of the SS outcome for subject B3 was 99% in the first CRF and 37% for the first FR 31 condition. In the second CRF condition and the FI 30 condition, preference for the SS outcome was 98% and 39% respectively. In the third CRF condition,

results revealed a preference of 97% and for the second FR 31 condition preference was shown at 59%. For this subject soft commitment was clearly shown in the first FR 31 condition, which revealed a shift of 62%. However, for the second FR 31 condition the shift was only 38%. This shift for both FR 31 conditions showed a mean preference for the LL outcome of 50%. For the FI 30 condition, there was a shift of 59%. Thus, subject B3 showed approximately the same degree of soft commitment in both the FR 31 and FI 30 conditions.

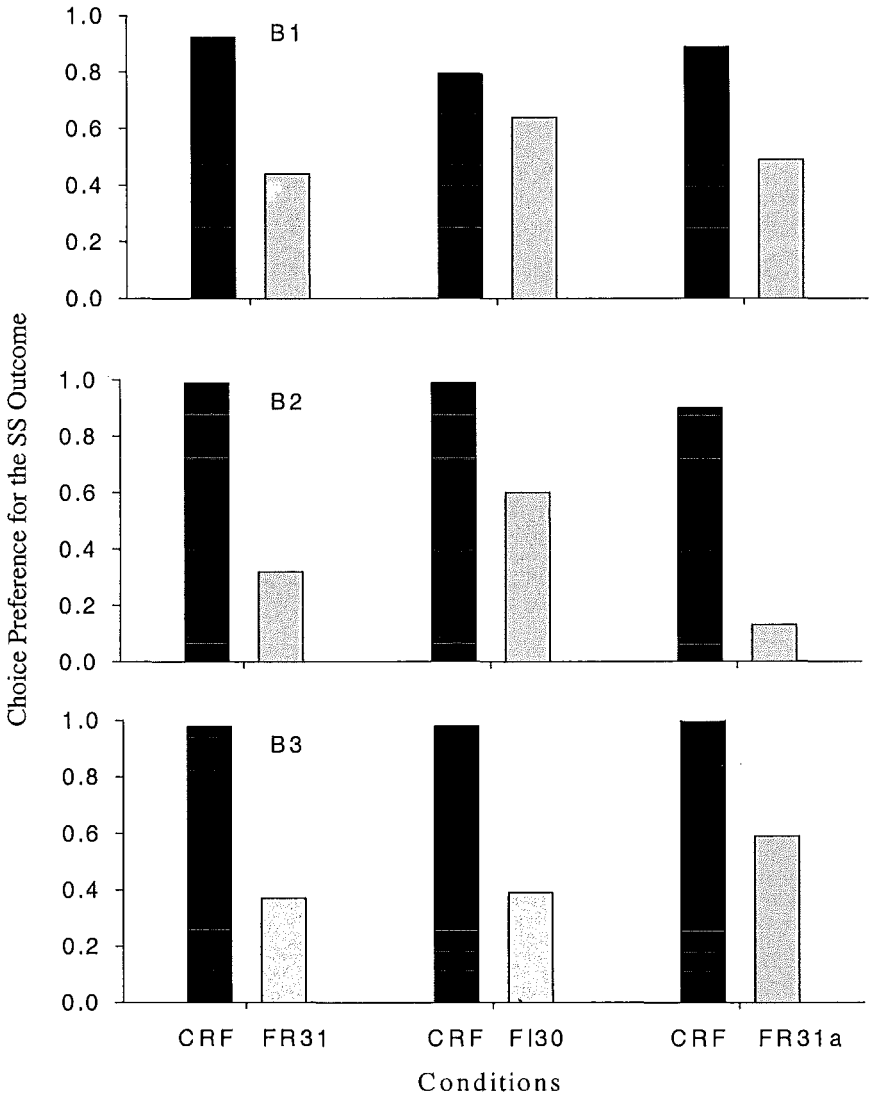


Figure 3 : Comparison of means between CRF and non -CRF conditions for subjects B1-3.

In Figure 4 the mean preference for the SS outcome in the first CRF and FR 31 and CRF and FI 30 conditions is shown for subject B4.

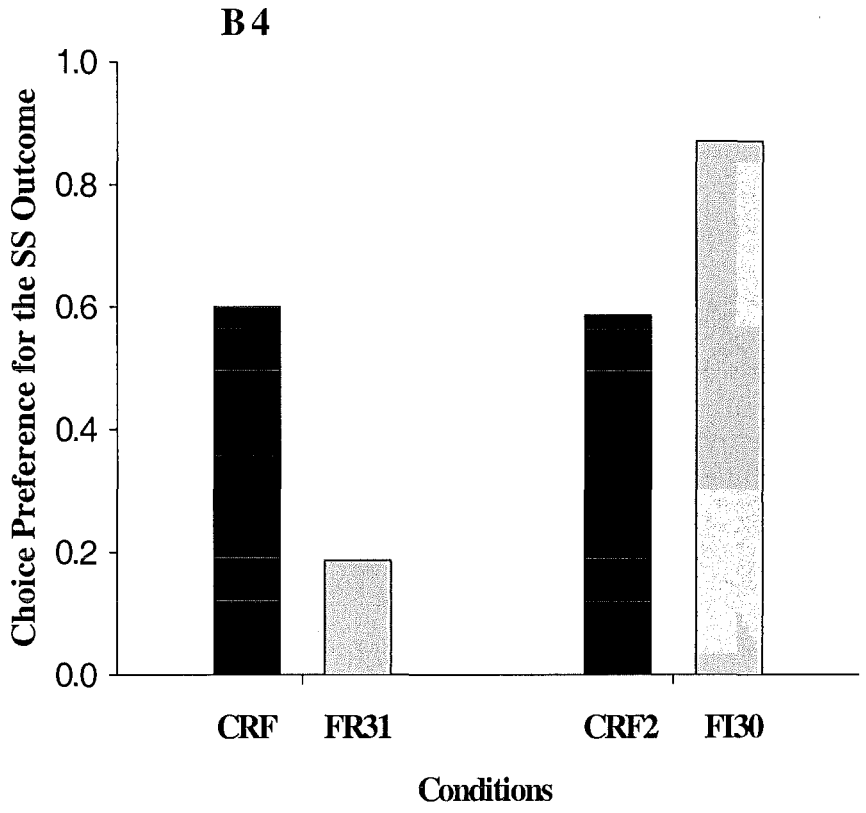


Figure 4 : Comparison of means between CRF and non -CRF conditions for subject B4

The mean preference for the SS outcome for subject B4, in the first CRF condition was 60% and for the first FR 31 condition was 19%. In the second CRF and FI 30 conditions preference was 59% and 87% respectively. For this subject soft commitment was evident in the FR 31 condition, specifically a shift of 41%. However, in the FI 30 condition, there was a

negative shift of 28% towards the SS outcome. Thus, subject B4 showed soft commitment in the FR 31 condition but not in the FI 30 condition.

When all the data was aggregated, the group mean shift preference for the LL outcome associated with the FR 31 condition was 58% across all subjects. For the FI 30 condition, the group mean shift preference for the LL outcome was 35%. Therefore, these results showed that there was a greater degree of soft commitment in the FR 31 measured as the shift in preference compared to the FI 30 condition.

The average durations to complete both the FR 31 schedules in seconds for subjects B1, B2 and B3 were 13.8-s, 22.7-s, 23.1-s, respectively. For subject B4 the averaged duration to complete the FR 31 schedules was 15.4-s. The overall mean durations across all birds was 18.7-s. This value is close to that obtained by Siegel and Rachlin's study which revealed a 20.55-s mean duration across all birds in this condition.

Figures 5 and 6 show the percentage of responses for the SS outcome as a function of FR response number or elapsed time during the FI 30-s schedule. The horizontal lines for the FR 31 condition are similar to results of Siegel and Rachlin and suggest that once a subject had made the first response on the LL alternative during an FR 31 trial, it continued to respond on that key until the outcome was obtained. Thus, there was minimal defection once the LL alternative had been chosen.

In the FI 30 condition (as shown in Figure 5), only one subject (B3) maintained a stable preference over the interval. Results revealed that this subject was showing self-control in

both the FR 31 and FI 30 conditions. The other three subjects (B1, B2, and B4) began the interval with a preference for the LL key but as the interval progressed preference for the SS increased. Therefore, these subjects were more likely to "defect" from the LL pattern in the FI 30 condition.

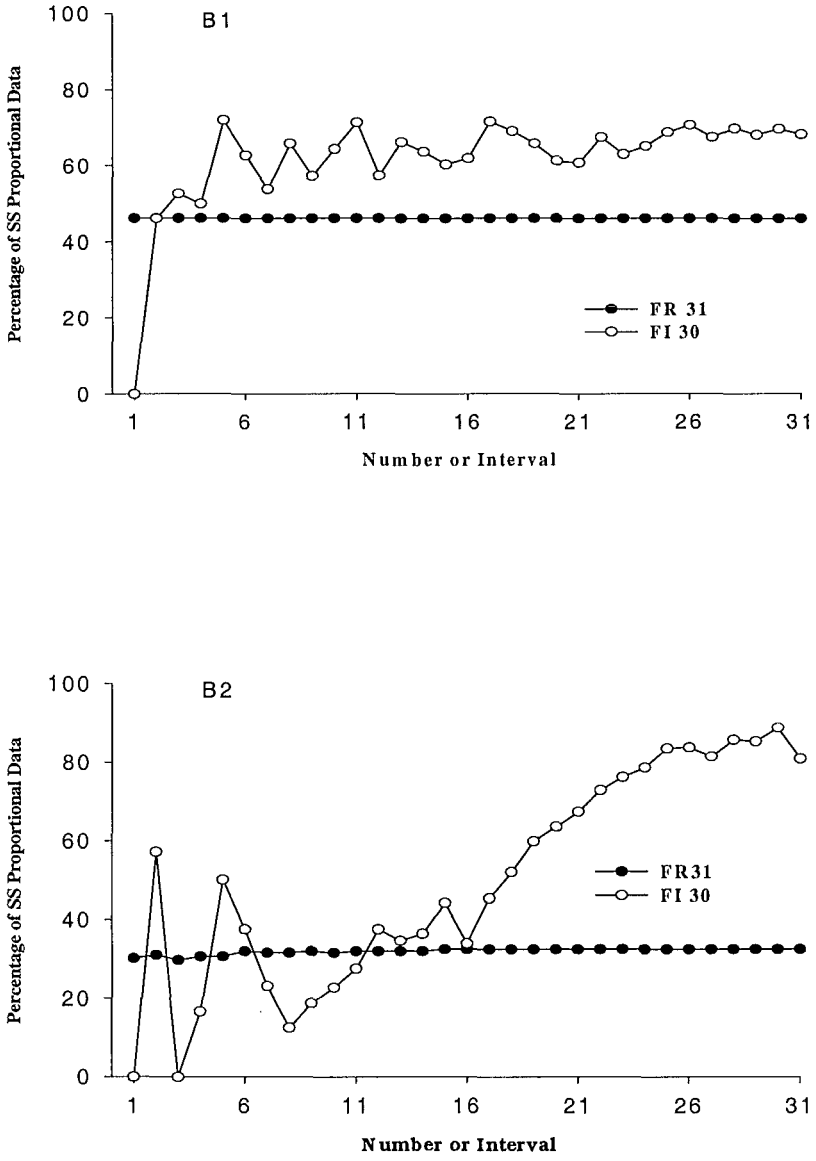
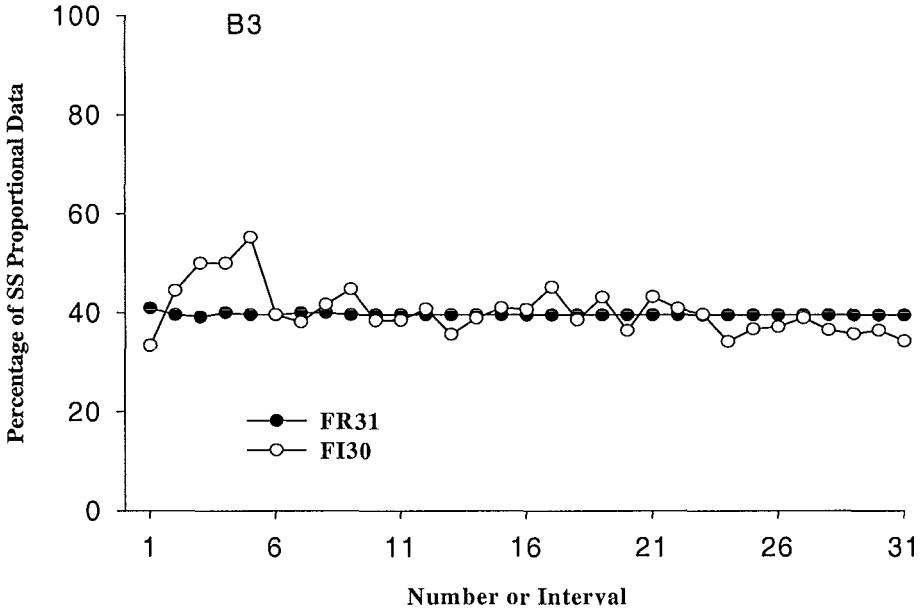


Figure 5: Comparison of FR 31 and FI 30 conditions as a function of response number or time for subjects B1 and B2.



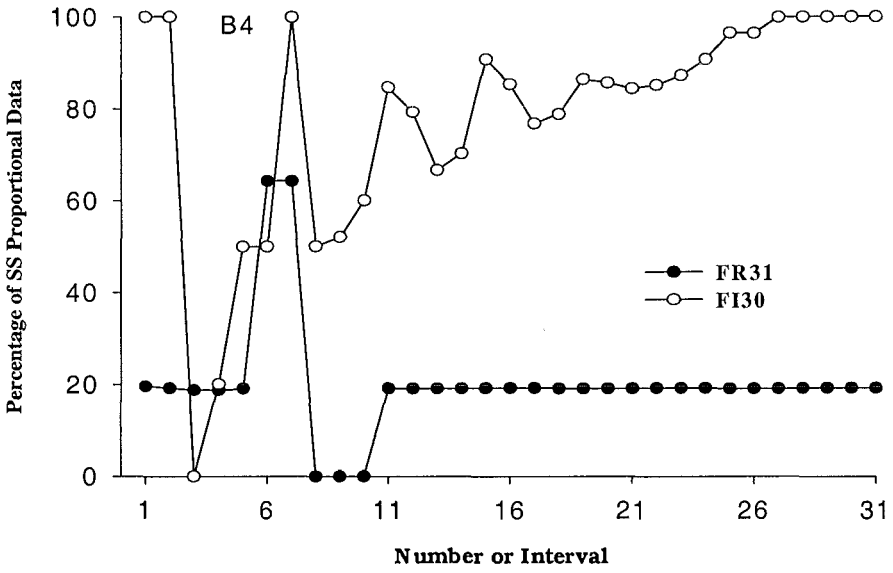


Figure 6: Comparison of FR 31 and FI 30 conditions as a function of response number or time for subjects B3 and B4.

Summary of Results

In this first study, soft commitment was demonstrated by the subjects responding in a pattern of behaviour that enabled obtainability of the LL outcome, despite having opportunities to defect between the alternatives. Soft commitment was exemplified at its best in the FR 31 condition where this engaged pattern of responding occurred. When compared to the FI 30 condition, results showed there was an overall stronger preference for the SS outcome. This preference was shown in Figures 5 and 6 where three of the four subjects (the exception being subject B3), preference for the SS outcome increased in the FI 30 condition. In the CRF condition a preference for SS outcome was shown which clearly showed impulsivity. In summary, these results appear to support Siegel and Rachlin's (1995) findings.

Siegel and Rachlin (1995) argued that the connection between the extended pattern of responding and self-control was contingent on the cost of switching between alternatives. Siegel and Rachlin further contended that a commitment of choice for the LL outcome was made initially at the beginning of the FR trial and the cost of switching was enough to outweigh the preference reversal of obtaining the impulsive alternative.

To assess even further the results of the extended pattern of responding, we will explore the area of temptation and its implications in a soft commitment paradigm.

EXPERIMENT 2

An interesting question is when soft commitment behaviour might be disrupted by the occurrence of a "temptation". Temptation in this experiment was modelled as an additional impulsive choice. A temptation cue or stimulus was presented when the two other alternatives (the SS and LL alternatives) were available at the same time. To date no research has examined the systematic effects of temptation cues with non-humans, in particular with the soft commitment paradigm. Moreover, we were interested to see whether the inclusion of temptation trials (FR 31 tempt) would affect ongoing preference for the SS or the LL outcome. The principle of "independence from irrelevant alternatives" would predict that adding a competing alternative (e.g., a temptations cue) should not affect choice distribution between the SS or LL alternatives (Luce, 1977; Davison 1982; Fantino and Dunn, 1983).

We also predicted that the likelihood of 'succumbing' to temptation would depend on what point during the FR 31 schedule that the temptation cue was presented. Specifically, we predicted that the likelihood of yielding to the temptation manipulation would be relatively high at the beginning of the FR 31 trial. On the other hand, if a prior investment towards soft commitment had occurred, progression in the FR 31 trial would show an increased resistance to the temptation stimulus.

Experiment 2 consisted of two phases. Firstly, there were 10 individual FR 31 tempt sessions presented to each subject. Each FR 31 tempt sessions was followed by two to

four baseline sessions (i.e., FR 31 sessions with no temptation cue trials). The second phase consisted of a block of six consecutive baseline FR 31 sessions, six more FR 31 tempt sessions followed by seven sessions during which the temptation cue was extinguished. Then six more FR 31 tempt sessions were conducted. The question addressed in this phase was whether extinguishing the temptation cue would affect the likelihood of succumbing in the temptation sessions. Performance of the FR 31 tempt trials was measured by the number of succumbs to responding and measured response latencies from the onset of the temptation cues.

METHOD

Subjects

Three subjects were used in this experiment. These subjects were also used in Experiment 1. Birds were maintained at approximately 85% of their free feeding weights by additional post feeding when required after experimental sessions. Water and grit were continuously made available to the birds.

Apparatus

Same as Experiment 1.

Procedure

Phase 1: FR 31 tempt sessions:

Sessions were run at approximately the same time of day, seven days per week. First, subjects were given additional training with the temptation cue. During this "refresher course" of the temptation cue, both side keys (SS and LL keys) were darkened. When illuminated the temptation key (centre key) was red and remained lit until the subject had responded or 3-s elapsed, whichever occurred first. Next, the SS outcome was presented followed by a 30-s blackout. The SS outcome was the same as that in Experiment 1 (i.e. a 0.5-s delay followed by 2.5-s access to food).

Following the temptation refresher course additional baseline FR 31 sessions were run for all subjects (31 for subjects B1 and B2 and 29 FR 31 for subject B3). Then FR 31 tempt sessions systematically replaced every second, third or fourth FR 31 session. FR 31 tempt sessions were identical to regular FR 31 sessions (i.e., 12 forced choice and 45 free choice trials), except that 16 of the free choice trials were designated pseudo-randomly as FR 31 tempt trials. Of the 16 FR 31 trials, four were arranged to occur after the 4^{th}, 12^{th}, 20^{th} and 28^{th} FR responses. The presentation of the temptation cue was response-contingent. For example, for a trial on the 28^{th} response location, the centre key would be lit red when the subject had made the 28^{th} response on the FR 31 tempt trial. One emitted response on the temptation cue resulted in the subject obtaining the SS outcome. If the subject yielded to the temptation cue, the inter-trial interval began. The number of succumbs and response latencies were aggregated and recorded for individual and grouped

subject data. These FR 31 tempt trials were analysed to observe whether the firm patterning of FR responding would be weakened by the temptation probes. If the subject did not respond to the temptation cue, it was extinguished after 3-s or when the FR 31 was completed, whichever occurred first.

Phase 2: FR 31 tempt sessions with an extinction procedure.

The objective of the extinction phase was to test whether pairing of the temptation cue with non-reinforcement outside the soft commitment choice would affect responding to the temptation cue when subjects returned to the choice procedure. The extinction training was identical to the "refresher course" except that no reinforcement was provided. That is, on each trial the centre key was lit red. This terminated when a response occurred, or 3-s had elapsed, whichever occurred first. There were 80 trials per session, separated by a 30-s intertrial interval. By the end of the seven extinction sessions, all subjects were responding only occassionally to the temptation cue.

After completion of extinction training, six additional FR 31 tempt sessions were conducted in which the subject's number of succumbs to the temptation cue and response latencies were measured. For instance if the number of succumbs decreased and response latency durations increased we could conclude that extinction may provide an effective way to increase self-control, as shown in clinical studies (Drummond and Glautier, 1994).

After Phase 1, at least 5 baseline sessions were conducted, followed by six consecutive FR31 tempt sessions were conducted, followed by seven extinction sessions, followed by six additional FR 31 tempt sessions.

RESULTS

The primary data analysed were the number of centre key pecks ("succumbs") following each temptation cue which was determined using aggregated data over sessions. In total there were 30 FR 31 tempt sessions that comprised of 10 FR 31 tempt sessions assigned to each subject. From these data we computed the the probability of pecking the temptation cue ("succumbing") as a function of FR response location for all subjects. These results are shown in Figure 7. Response latencies to pecking on the temptation cue were another measure recorded to examine whether they increased or decreased depending on the response location within the FR 31 that the temptation cue was presented (as shown in Figure 8).

Secondly, we compared results on temptation trials that were presented before and after extinction training with the temptation cue. The question was whether extinction of the temptation cue would reduce the likelihood of succumbing as well as increasing the latency to succumb. This analysis involved computing the probability of succumbing over the six FR 31 tempt pre-extinction sessions that were given to the subjects. Next, the probability was computed for the six sessions that followed extinction training (refer to Figure 10). In addition, average response latencies were obtained to check for a change in latency to succumb after extinction training (see Figure 11).

The percentage of "succumb" responses made on the ten FR 31 tempt sessions, following each temptation cue was determined using aggregated data over sessions. This

data was taken from the probability of pecking the temptation cue ("succumbing") as a function of FR response location for all subjects. These results are shown in Figure 7.

Figure 7 showed that both subjects B2 and B3 consistently succumbed on all temptation cues throughout the test sessions. However, for pigeon B1 initially the probability of succumbing was 100% for response location 4. Nonetheless, when responding progressed throughout the FR 31 tempt trials the probability of succumbing decreased on the 12th, 20th and 28th response locations for this subject.

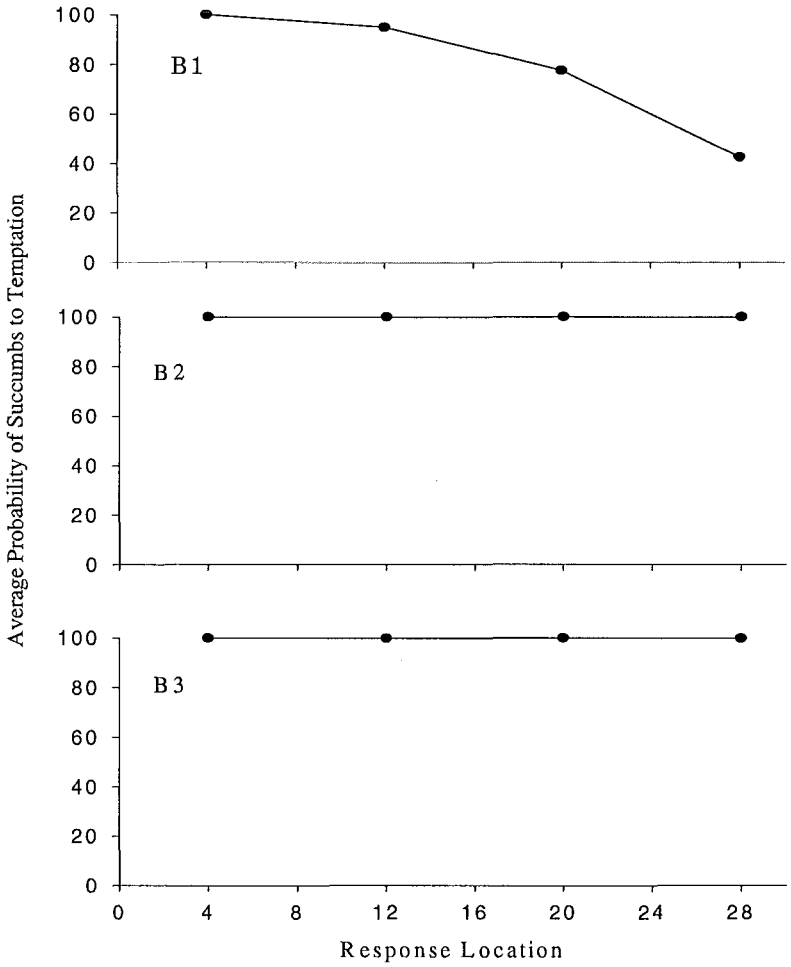


Figure 7: The probability of pecking on the temptation probes for individual subjects.

We also analysed the latency to respond to the temptation cue for those trials in which the subjects succumbed. Figure 8 displays the mean values of the response latencies to the temptation cue for individual subjects. Response latencies for all subjects were measured in milliseconds. For each subject, mean latency times of pecking on the temptation cue were longer on the 20^{th} and 28^{th} response than on the 4^{th} and 12^{th} response locations. This demonstrates that for those trials in which the birds succumbed, there was relatively greater resistance to temptation as the FR 31 tempt schedule progressed because the latencies to succumbing were greater.

Another question we examined was whether the inclusion of FR 31 tempt trials had any effect on the pigeons' choices at other times during the session. In particular would the degree of soft commitment shown during the test (FR 31 tempt) session be different from that shown in the adjacent baseline sessions? The rationale for this question is that for humans, experience of succumbing (or not) to temptation might affect the likelihood of self-control behaviour in other aspects of their lives. Thus, this question was investigated from the standpoint of developing an animal model for temptation and soft commitment in humans.

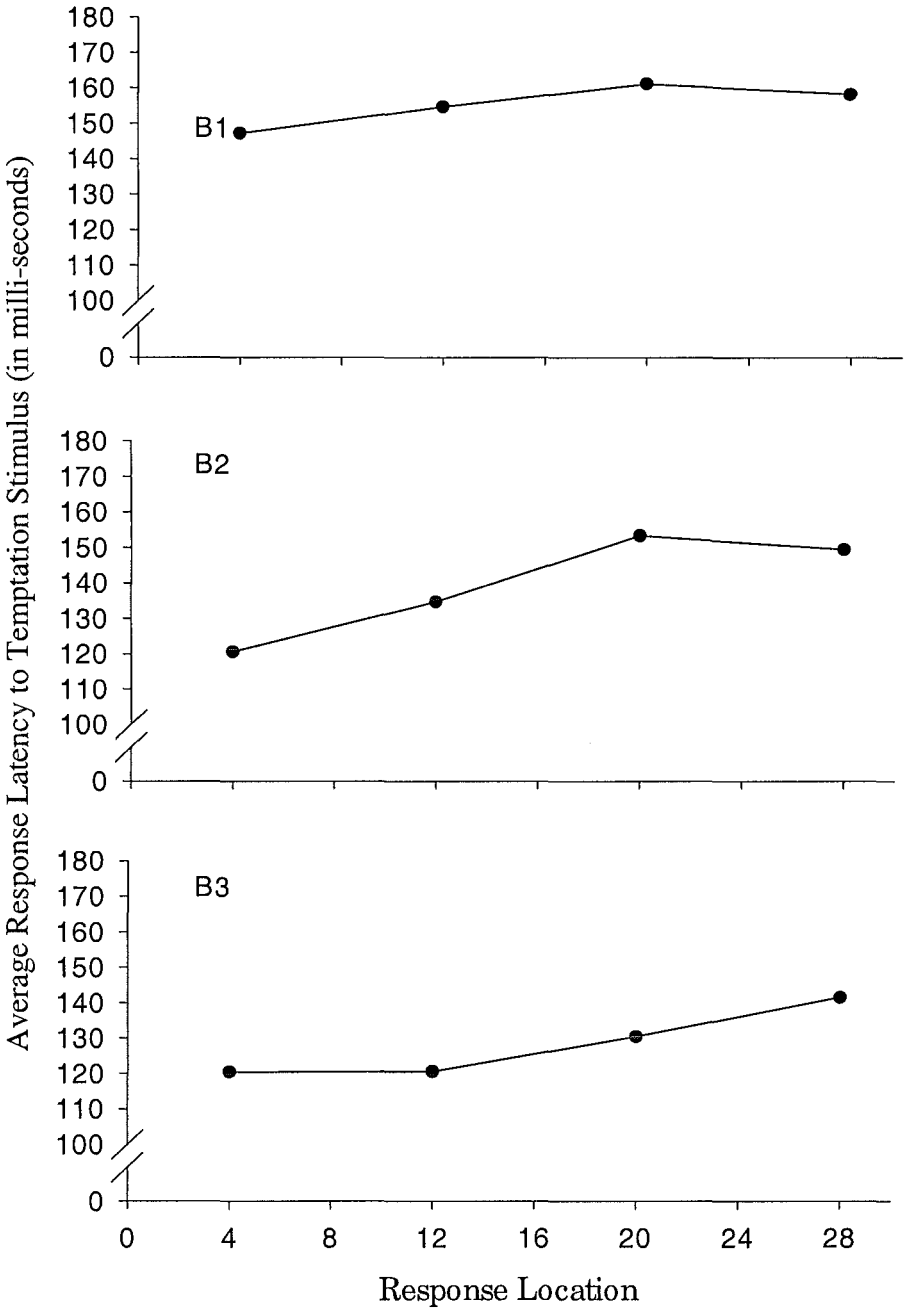


Figure 8: Average latency times to temptation stimulus at the 4, 12, 20, 28 locations of the FR 31 trials.

Figure 9 shows preference for the SS outcome during FR 31 tempt and intervening baseline sessions. Across subjects, there were systematic differences in preference for the SS outcome depending on whether or not temptation trials were included. The comparison of the overall mean preference for the SS outcome in the FR 31 tempt and FR 31 sessions (the averaged baseline sessions prior to and after the FR 31 tempt sessions) across all subjects was 50% and 56% respectively. These results suggest that the SS outcome was more preferred in the base-line FR 31 sessions.

The overall mean, however is a crude measure of accuracy. Of interest is whether or not there were significant differences for individual comparisons. A further break down of the data was used to assess individual data from the first FR 31 tempt sessions. A sign analysis comparedd the mean preference for the SS outcome between the prior FR 31, post FR31 and FR 31 tempt sessions across all subjects. 21 of the 30 individual comparisons showed less preference for the SS outcome in the FR 31 tempt sessions than the average of the preceding and following baseline sessions. Findings from the sign test revealed a significant result, $z = 2.01$, $p < .05$. Therefore across birds, it was shown that consistently preference for the SS outcome was reduced in the FR 31 tempt sessions compared to the adjacent baseline preferences.

Contrary to expectations, these results appears to be somewhat surprising to what would we would expect to find. For instance, in a context where temptations are available, one would expect to find an increased preference for the temptation alternative.

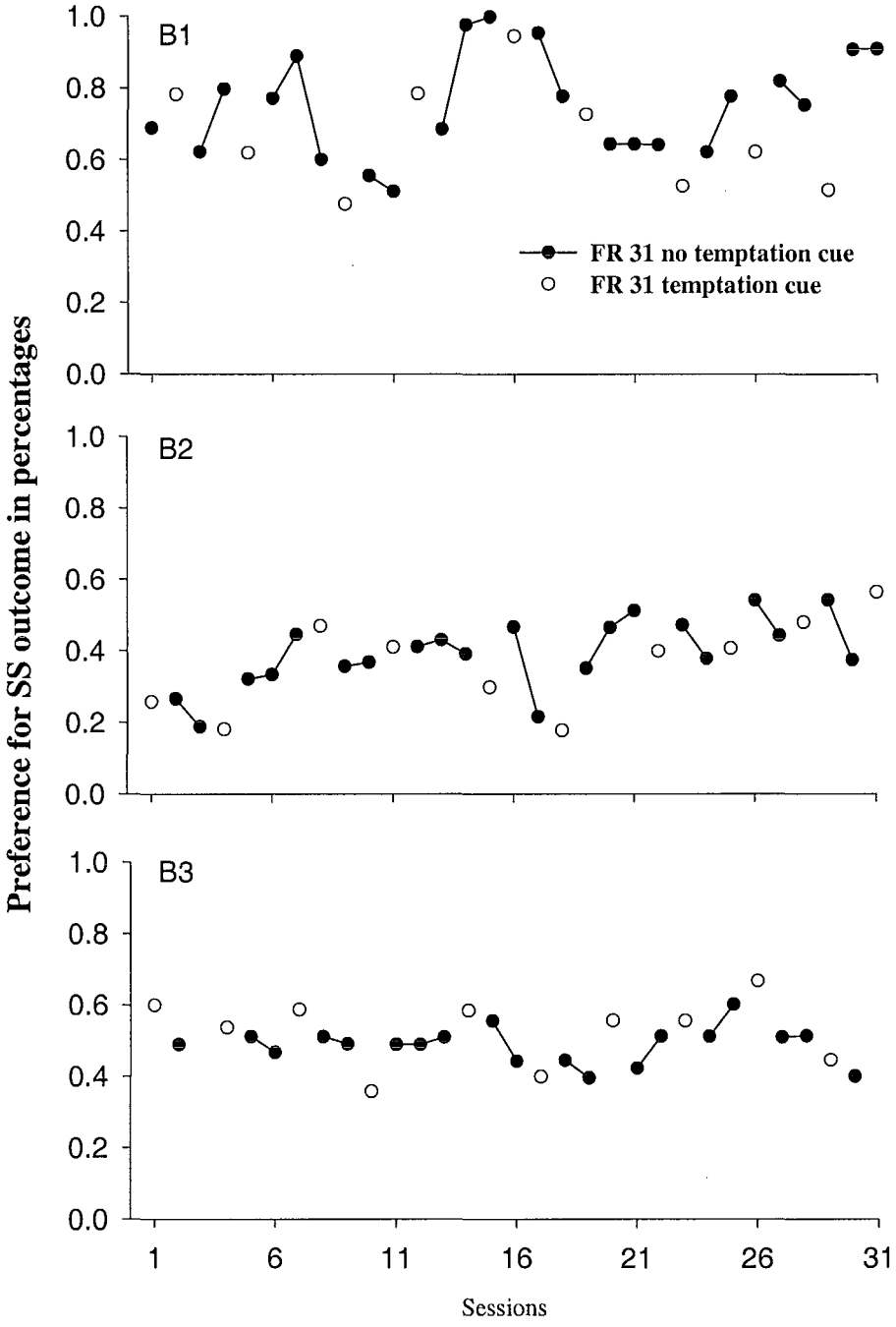


Figure 9: Preference for SS outcome for base line and test sessions during the temptation phase.

We also examined the effects of extinction training to assess whether such training would reduce the likelihood of succumbs. Figure 10 shows the mean responding to the temptation cue prior to and after extinction training for each subject.

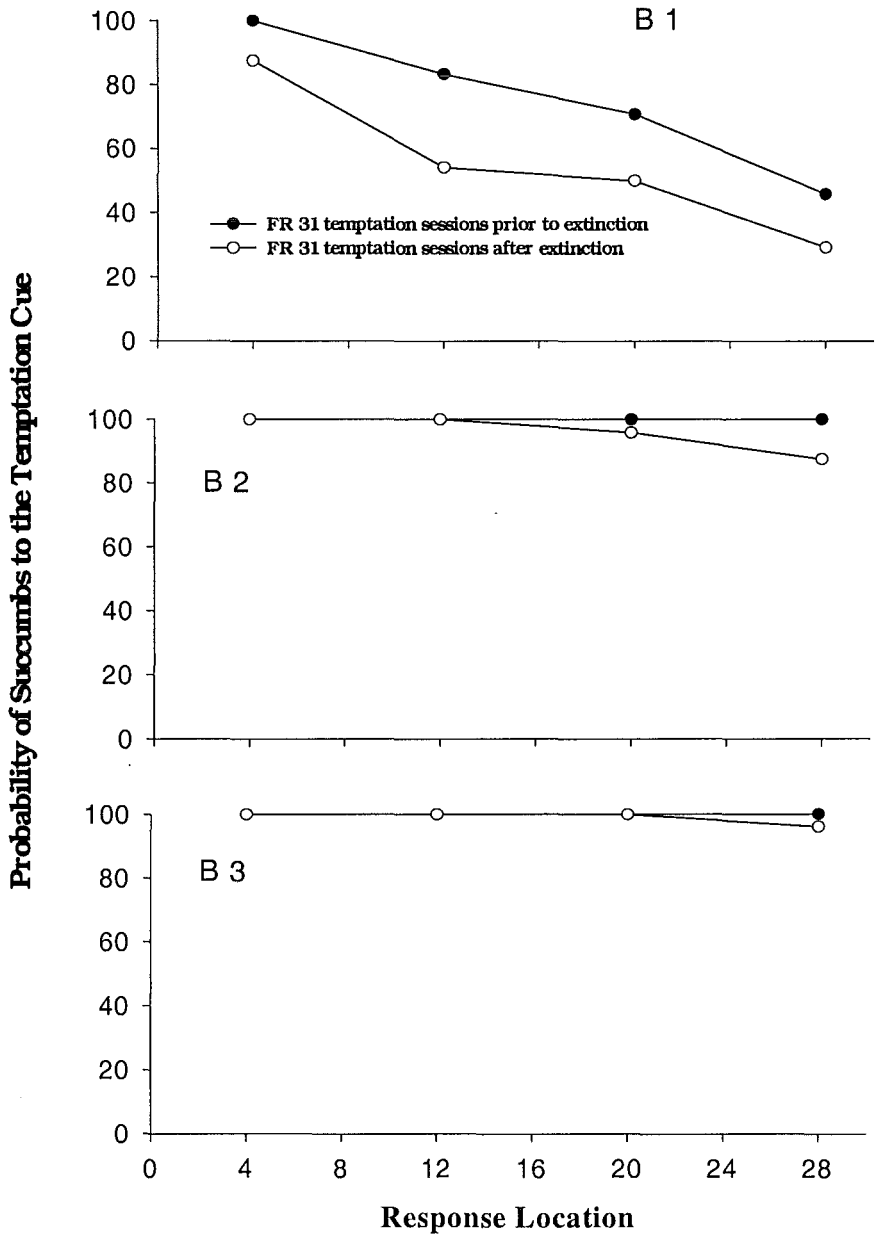


Figure 10: Probability of pecking to the temptation cue prior to and after extinction training for all subjects.

Figure 10 shows that extinction training reduced the probability of succumbing for all subjects, at least to some extent. The greatest effect observed for subject B1 whose data showed a reduction in succumbs for all response locations. For subjects, B2 and B3 there was a small reduction for the 20^{th} and 28^{th} response locations (subject B2) and 28th response location (subject B3).

Figure 11 shows the mean response latencies to the temptation cue as a function to prior and post extinction training across subjects. Before extinction training subject B1's response latencies to the temptation cue increased during the progression of the FR 31 tempt trials. After extinction had completed response latencies to the temptation cue increased but at the 20th response location response latency durations decreased. Similarly, response latency differences were much larger preceding extinction training for subjects B2 and B3. That is these subjects showed response latencies increased from the 4^{th}, 12^{th}, 20^{th} through to the 28^{th} response locations. In contrast, to subject B1's findings, when extinction was given to the other subjects, response latencies decreased on all response locations in the FR 31 tempt trials.

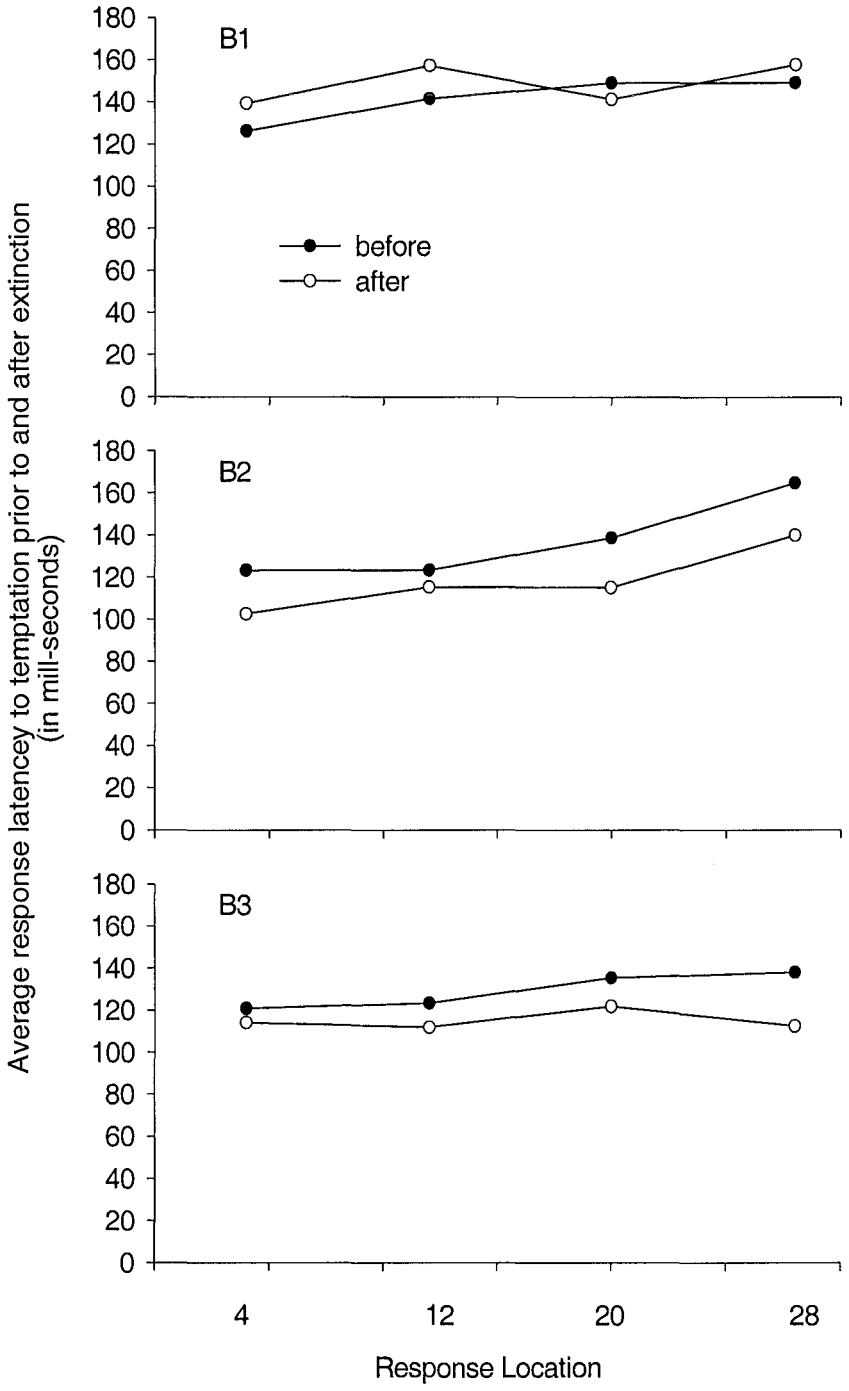


Figure 11: Averaged response latencies prior to and after extinction training across all subjects.

Summary of Results

Baseline performance on the FR 31 trials was disrupted by the introduction of an imposed temptation manipulation (or temptation cue). The effects of the temptation cue were measured by the mean number of succumbs to the temptation cue in these sessions across subjects. Response latencies were also recorded to investigate whether during the progression of the FR 31 trial response latencies increased.

In the first analysis, where 10 FR 31 tempt sessions were conducted, one subject was likely to respond to the temptation cue over the progression of the FR 31 tempt trial. Whereas, for the other two subjects they consistently succumbed on all temptation cues at every designated response locations. However, all subjects response latencies to the temptation cue increased because of resistance to the temptation cue. One way to quantify the effects of the temptation cue was to compute and compare the mean of the baseline performance (preference of the SS outcome in the FR 31 sessions) before and after the FR 31 tempt sessions to the mean preference for the SS outcome in the FR 31 tempt sessions. Unexpectedly these comparisons suggested that there was a significant difference in the FR 31 tempt sessions compared to the FR 31 sessions where a stronger preference for the LL outcome was indicated.

In the second analysis, we compared the effects of pre and post extinction training to assess whether succumbing to the temptation cue reduced. For all subjects the likelihood of succumbing decreased after extinction training although the amount of reduction varied across subjects.

Response latencies before and after extinction were mixed. One subject's pre and post extinction comparison data for response latencies to the temptation cue showed an increase in both conditions. For two out of the three birds response latencies increased prior to extinction. Conversely, response latencies decreased after extinction training had completed.

DISCUSSION

The first aim of was to partially replicate Siegel and Rachlin (1995) soft commitment study using pigeons. The second aim was to control for order effects that might have previously precluded clarity between the experimental conditions. To addresses these questions the conditions were counterbalanced to control for order effects by conducting an ABA (FR 31 – FI 30 – FR31) design. This was of particular interest to the first study because examining the conditions could exemplify where soft commitment took place. A second study was an extension to the soft commitment research where we measured the effects of a temptation manipulation in FR 31 trials.

Siegel and Rachlin (1995) found significant differences between conditions (CRF, FR 31, FI 30 conditions). Similarly significant differences between conditions were found in the present study but further analysis showed that there were non-significant differences between the FR 31 and FI 30 conditions and CRF and FI 30 conditions. Therefore, the counterbalancing of conditions might have provided less ambiguity between conditions with the present study's findings.

To test the magnitude of soft commitment, comparisons between the CRF and FR 31 or FI 30 conditions were conducted. Soft commitment would be shown as a function of change in preference from the SS to the LL outcomes. Group data revealed a higher preference of the LL reinforcer in the FR 31 condition compared to the FI 30 condition.

The data showed that responding in the FR 31 condition, promoted soft commitment of obtaining LL reinforcement, thus enhancing self-control. Moreover, these results were consistent with Siegel and Rachlin (1995) findings where soft commitment was found in the FR 31 condition.

On the other hand, a clear preference for the SS reinforcement became evident when obtained response requirements in the CRF condition were averaged across all subjects. This finding lends further support to Siegel and Rachlin (1995) study in which a preference of near exclusivity for the SS reinforcer was shown in the CRF condition, thus revealing impulsivity.

The first study also aimed to investigate what controls choice in soft commitment, whether it is the delay (time) or a behavioural pattern (number or responses) that serves as the critical variable for determining soft commitment? According to preference reversals as time gets closer to obtaining reinforcement the organism switches preference from the obtaining the LL outcome to the obtaining the SS reinforcement. However, when time is moved back from obtaining reinforcement preference is shown for the LL outcome over the SS outcome (Rachlin and Green, 1972). It was surprising that soft commitment was found in the FR 31 condition because the mean duration to complete the trial was 18.7-s compared to the FI 30 condition that took 30-s to complete the trial. Therefore, according to the choice reversal, preference for the SS outcome should have been found in the FR 31 condition; rather a stronger preference for the LL outcome was shown. Conversely, a preference for the SS was shown in the FI 30 condition. Discussion of the theoretical implications of this is reserved until a later stage.

The same trend was noted in the proportional data of Figures 5 and 6 where three of the subjects' preference for the SS outcome increased in the FI 30 condition. The same figures for the FR 31 condition showed when the pigeon started pecking on the LL alternative minimal switching occurred and as a consequence the LL outcome was obtained. These results suggest that they were comparable to the findings discussed in (Rachlin 1995; Rachlin and Siegel, 1995 and Rachlin, 2000).

The second study explored a possible behavioural model for temptation. We hypothesised that at the beginning of the FR 31 tempt trials succumbing to the temptation cue would be high. However towards the end of the FR 31 tempt trial succumbs would decrease and response latencies would increase. Thus with the decrease in succumbs and increase in response latencies these expectations might show preference for the SS or LL outcome. If the preference for the LL outcome was shown then this would suggest that soft commitment could be found despite opportunities to switch to the temptation alternative.

This experiment is the first one of its kind to examine and extend factors that interrupt soft commitment with an imposed temptation manipulation. Pigeons were tempted during the FR 31 tempt schedule in which an illuminated centre key operated simultaneously with the SS and LL keys. If the pigeon pecked on this key, immediate access to grain was delivered (the same magnitude and delay to that of the SS outcome).

For all subjects, either the probability of responding on the temptation key or the latency to respond changed systematically relative to when the temptation cue was

presented in relation to progression towards completing the FR 31 trial. Evidence of response probabilities of succumbing to the temptation and response latencies was taken from averaged responses for preference of the SS, LL or temptation cue from the FR 31 tempt trials. For one subject the number of temptation succumbs increased at the beginning of the trial, however as the FR 31 tempt progressed the succumbs decreased and thus response latency durations increased. Therefore, this subject's data supported the hypothesis of this experiment. For the other subjects they consistently succumbed on all of the temptation cues throughout the FR 31 tempt trials. Indeed these results are conceivable, when considering interruptions that abandon the preferred alternative occur when switching to contingencies of temptation.

Unexpected significant differences of a decreased preference for the SS outcome was found in the FR 31 tempt condition. This finding compared to the baseline FR 31 condition and post FR 31 conditions showed a larger preference for the SS outcome. These obtained results seemed counterintuitive because we would normally expect an organism to show a greater degree of yielding to temptation in it's natural context (Fisher and Mazur, 1997).

Similar findings were obtained with human subjects. For example, in the Mischel studies when visible rewards were presented to children in a waiting situation often the children yielded to temptation by choosing the SS reward over the LL reward (Mischel & Ebbesen, 1970; Mischel, Ebbesen, & Zeiss, 1972; Mischel, 1974; Mischel & Patterson, 1976; Mischel, 1981; Mischel, Shoda & Peake, 1988; Mischel, Shoda & Rodriguez, 1989; Mischel, Cantor, & Fieldman 1996).

Although it is not possible to ascertain it from the data, it might be indicative that the subjects may have established a prior investment of obtaining the LL over the SS outcome. Similarly, the subjects may have established this responding behaviour from reinforcement history or carry over effects where in the previous study in the FR 31 trials a stronger preference for the LL was obtained. Nonetheless examination of the individual data showed that there was a resistance to the temptation cue in the FR 31 tempt condition.

The question that remains is whether pigeons would cease responding if the temptation cue was extinguished. To address this an extinction phase was introduced to examine whether the effects of extinction of the temptation cue would reduce the number of succumbs and increase response latencies during the FR 31 tempt trials. Indeed this was found for one of the subjects responding on the temptation cue decreased and response latencies increased prior to and after extinction training. This finding indicated that the subject was showing resistance or self-control to the temptation stimulus. For the other two subjects after the extinction phase responding on the temptation cue showed a slight decrease on response locations 20 and 28.

In summary, for both phases of this study, we anticipated whether the inclusion of temptation trials (FR 31 tempt) would affect ongoing preference for the SS or the LL outcome. Succumbing showed an orderly decrease of succumbs and response latencies occurred increased over the progression of the FR 31 tempt trials. Thus, it seems likely that pigeons could learn to discriminate between the three alternatives and hence resist the temptation cue.

GENERAL DISCUSSION

The present study revealed that soft commitment was found in the FR 31 condition and that an extension to developing a behavioural temptation model was used to test the soft commitment behaviour. These results showed that the subject(s) were able to show a potential to resist temptation towards the end of the FR 31 tempt trials with and without a extinction procedure.

The following section of this thesis will account for some of the theories that are relevant to the findings of the study. The results of this thesis will subsequently be discussed in terms of their implications to soft commitment and temptation. Lastly, possible limitations of the studies and suggestions for future research will be considered.

Choice Behaviour

Previous research in choice has revealed that quantitative models predict self-control (Logue, Rodriguez, Pena-Correal and Mauro, 1984; Grace, 1994). These models provide plausible explanations of self-control that are adaptations taken from the Matching Law (Hernstein, 1961). In particular, attention has been paid to delay, reinforcer magnitude and preference that are measured by response distribution (Grace, 1999).

One feature obtained from the choice models is the preference reversal model, which explains self-control and other related areas such as commitment and soft commitment (Baum and Rachlin, 1969). As time gets closer in proximity to obtaining the

reinforcer, the organism switches preference for obtaining the LL outcome to the SS outcome. When time is shifted back to where the delay gets longer to the available reinforcer, preference is shown for the LL outcome over the SS outcome. The point of where switching occurs can be accounted for and better understood using Equation 2.

Previous findings claimed that soft commitment was a pattern of engaged responding over time that was dependent on a cost (Siegel and Rachlin, 1995; Rachlin, 1995; Rachlin, 2000). Therefore, Equation 2 would predict the preference reversal of switching from responding on the LL to responding on the SS alternative.

The findings in the present study indicated that the choice reversal occurred in the FI 30 condition but not in the FR 30 condition. In the FR 31 and FI 30 schedules the pigeon could switch between choice options at any point of the sequence. Although in the FR 31 trials as the pigeon enters into this pattern of responding (pecking on the LL alternative) over time it can be seen that this responding is likened to a prior investment for obtaining the LL outcome (Rachlin, 2000). The cost of switching mid-pattern through the FR 31 trial was enough to surpass preference reversal (Rachlin, 1995).

Teleological Behaviourism

Teleological behaviourism has been proposed to address the nature of the underlying mechanism of self-control between classes of extended patterns of behaviours and classes of behavioural acts through time. (Rachlin, 1995; 1997; 1999; 2000). However, within the academic community, Rachlin's position on teleological

behaviourism is currently under a matter of debate (see Commentary / Rachlin, 1995 for review).

The distinction between act and pattern lies in its exposition of the temporal character of the SS versus the LL reinforcer through brief versus extended intervals (Rachlin, 1995). Interestingly the extended interval also embraces the SS reinforcer (Rachlin, 2000). Consider for a moment that an act enables a pigeon to gain access to consuming 4-s of food reinforcer. Therefore, prior responding (the overall pattern of the acts) that led to availability of the reinforcer might be partitioned into patterns of discrete actions.

The results from the first study suggest that each peck in the FR 31 schedules could be viewed as acts. While responding persisted (the extended pattern) in the trial this pattern of responding would lead to obtaining the LL outcome. Thus, each peck was seen as an investment in order to obtain the LL outcome (Rachlin, 2000). As a result in the present study and Siegel and Rachlin's (1995) study this extended patterning was found in the FR condition which enhanced soft commitment.

Rachlin's approach on self-control as temporally extended patterns parallels to the rubric of behavioural momentum (see Nevin, Mandell and Atak, 1983; Nevin and Grace, 2000 for review).

" We suggest that Rachlin's extended pattern is analogous to sustained responding in the initial link of a chain schedule in that, from a molar perspective, continued access to the terminal link reinforcer (analogous to health) depends on continued initial link responding (analogous to moderate drinking, low fat diet, etc) throughout the experiment."

(Nevin and Grace, 2000, p88).

Self-control is developed by reconstructing behaviour into wider patterns specifically through commitment and soft commitment. That is once the pattern commences, breaking of the pattern (e.g. falling off the wagon) becomes costly as further progression of the pattern continues over time (Rachlin, 2000). This cost of pattern disruption can over come the value of a particular temptation. The second study's findings showed in Phase One that the FR 31 tempt session produced a significant difference of weaker preference for the SS outcome compared to the two adjacent FR 31 sessions. These findings indicated that in the FR 31 tempt sessions obtaining the SS or the LL outcome was more salient than switching to pecking on the temptation cue. However further analysis would be required to see whether preference for the LL outcome was shown to support Rachlin's extended patterns theory.

In relation to human problems of self-control, the cost of established patterns allows individuals to control themselves. This was shown in Mischel's delay of gratification studies with children who waited longer when they engaged themselves in singing songs, going to sleep, turning away from the rewards and playing with toys

(Mischel and Ebbeson, 1972). Such patterns promote self-control by surpassing temptations between immediate (less preferred) and delayed (more preferred) outcomes.

In summary, self-control is not just a LL reinforcer for specified behaviour but rather a sequence of behaviours that terminates at LL reinforcement. The acts of responding may be of relatively low value but help to constitute the bigger teleological pattern of obtaining the LL over the SS outcome. Therefore the science of self-control involves the contingencies of behaviour that optimises LL reinforcement as consistently shown in the FR 31 schedules in the present study and (Siegel and Rachlin, 1995).

Luce's Choice Axiom (or the "independence from irrelevant alternatives")

The second study extended soft commitment research by adding a temptation manipulation. Such an extension has the opportunity of testing Luce's (1977) choice axiom where the adding of another alternative should not influence choice distribution between two alternatives. The most direct test of this theory can be examined with a presentation of a temptation cue to fixed ratio responding in the second experiment. That is, the temptation stimulus was imposed at ordinal response locations (4^{th}, 12^{th}, 20^{th} and 28^{th}) on the FR 31 trial. Overall findings showed a significant difference of the lower rate of reinforcement for the SS outcome in the FR 31 tempt sessions compared to the baseline and post FR 31 sessions. This finding suggests that the temptation cue did not have an effect on the distribution of choices between the SS or

LL keys. Furthermore this finding provides further support towards Luce's theory of independence from irrelevant alternatives.

Limitations of the current study

Some limitations did not permit a clearer representation of the findings. That is in the first study subject B4 did not complete the ABA design as responding ceased in the second FR 31 condition. A further experiment where a complete ABA design in soft commitment occurred for all subjects would confirm even further responding demonstrated in the Fixed Ratio schedules. In the second study, the same subject did not partake. More data might assist in providing a better explanation of the effects to a temptation manipulation in the FR schedules.

Because of time constraints in the present study subjects received only a limited exposure to the FR 31 tempt extinction condition. A procedure in which non reinforced FR 31 tempt trials presented over a further extended period of time may result in better overall performance. Although the data showed sufficient promise in temptation experiments, further investigations would be required to provide further conclusive evidence. To address this issue ongoing research, more time allocation would help to clarify issues of temptation with operant procedures.

Future Research

Considerations for future research in this area do offer potential benefits in instrumental learning of self-control. In particular, investigations that compare the strength and resilience of self-control behaviour against temptation in self-control, and commitment experiments. Temptation research is important because it may empirically generalise an accurate representation of self-control in the real world context. Specifically, clinical studies that involve measuring responses of individuals with impulsive behaviours who can be placed in making complex choice decisions where temptation and soft commitment situations occur.

In summary, there are analogous similarities of soft commitment patterning in a human and non-human context. Therefore, a bridging study would provide ongoing research developments between the operant and human contexts (Fisher and Mazur, 1997; Logue, 2002).

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