

Bangor University

DOCTOR OF PHILOSOPHY

Models and treatment relapse and a pilot prevention intervention

Pritchard, Duncan

Award date:
2015

Awarding institution:
Bangor University

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

MODELS OF TREATMENT RELAPSE AND A PILOT PREVENTION INTERVENTION

Duncan Pritchard

Bangor University, 2015

Abstract

Children and young people with intellectual and developmental disabilities (IDD) often present problem behaviours such as aggression and disruption. These behaviours can be successfully treated using Applied Behaviour Analysis (ABA). Unfortunately, despite effective treatment, the relapse of problem behaviour is common, especially when treatment integrity is not maintained. Behavioural Momentum Theory (BMT) suggests that the relapse of problem behaviour is likely to be greater if the behaviour has been reinforced at high rates. Chapter 1 provides an introduction into BMT, treatment relapse, and role-play training and its effect on treatment integrity. Chapter 2 presents a more detailed discussion of BMT and a review of three treatment relapse models (i.e., reinstatement, resurgence and renewal). Chapter 3 reports the results of two reinstatement and resurgence experiments that evaluated the effects of alternating rates of reinforcement on attention-maintained problem behaviour presented by a 16-year-old male with IDD. The two experiments demonstrated that high rates of reinforcement can lead to greater magnitudes of treatment relapse. Chapter 4 describes a renewal experiment, again using alternating rates of reinforcement, that demonstrated similar findings. Chapter 5 reports the results of a long-term staff training programme that demonstrated that residential staff maintained high levels of treatment integrity following role-play training based on standardised scenarios than staff who received training via traditional methods. Chapter 6 discusses the implications of BMT and treatment relapse for practitioners and provides suggestions for future research.

ACKNOWLEDGEMENTS

I thank my supervisor, Marguerite Hoerger, for all her help and advice. I hope that I am able to repay her faith, and patience, in me as a behaviour analyst in the years to come. I thank all my colleagues at Aran Hall School for their support during the last five years, but especially Nicola Graham, Llio Eiri, Lorraine Hellowell and Simon Fothergill for their assistance with these studies. I hope that what we have published so far reflects well on the school, and helps bring the school the recognition it deserves. Of course, Brian Harris deserves a special mention, and not just for all his help with these studies. I must also thank Mark Flynn for his support and encouragement. Finally, I must thank Bud Mace for lending his considerable knowledge and expertise to this work, but most of all I thank Heather for everything.

Duncan Pritchard

CONTENTS

	Page
ABSTRACT	i
ACKNOWLEDGEMENTS	ii
LIST OF TABLES	v
LIST OF FIGURES	vi
CHAPTER	
1. INTRODUCTION	1
Reinstatement	2
Resurgence	3
Renewal	4
Treatment Integrity	5
2. TREATMENT RELAPSE AND BEHAVIOURAL MOMENTUM THEORY	7
Applications of BMT Paradigms	12
Alternative Reinforcement Treatments	14
Paradigms of Treatment Relapse: Reinstatement, Resurgence and Renewal	16
BMT Inspired Solutions to Treatment Relapse	31
Summary and Conclusions	35
3. CLINICAL TRANSLATION OF REINSTATEMENT AND RESURGENCE	37
Method	40
Procedure	41
Results	43
Discussion	46
4. CLINICAL TRANSLATION OF ABA RENEWAL	51
Method	54
Procedure	55
Results	56
Discussion	59

5. TRAINING STAFF TO AVOID PROBLEM BEHAVIOUR	63
Method	66
Results	72
Discussion	75
6. GENERAL DISCUSSION	78
REFERENCES	84

LIST OF TABLES

Table		Page
3.1	Mean response rates and obtained reinforcer rates contingent on problem behaviour in all phases except Phase 1a for Therapist 1 and Therapist 2	44
4.1	Mean response rates and obtained reinforcer rates contingent on problem behaviour in all phases for Therapist 1 and Therapist 2	58
5.1	Standardised scenarios	71
5.2	Role-play score sheet	72

LIST OF FIGURES

Figure		Page
3.1	Aggression and disruption per min for all sessions in the functional analysis and reinstatement phases and two VI VT treatment phases conducted by Therapist 1 and Therapist 2	44
3.2	Cumulative number of aggressions and disruptions per min during a single extinction session for Therapist 1 and Therapist 2	46
4.1	Aggression and disruption per min for all sessions in the VI VT treatment phases conducted by Therapist 1 and Therapist 2	58
4.2	Cumulative number of aggressions and disruptions recorded in a single extinction session in Context B for Therapist 1 and Therapist 2	59
4.3	Cumulative number of aggressions and disruptions recorded in a single extinction session in Context A for Therapist 1 and Therapist 2	59
5.1	Percentage of requests for restricted activities (RRA) responded to by providing and alternative choice (AC) or saying yes and providing a contingency (YC), and the total number of student RRAs observed	74
5.2	Percentage of requests for restricted activities (RRA) responded to by providing an alternative choice (AC), saying yes and providing a contingency (YC), and saying 'no', providing an explanation, or distracting a student from the request (NED) across in situ observations prior to and following staff training	75

CHAPTER 1

INTRODUCTION

Problem behaviour presented by children and young people with IDD can be successfully treated by interventions based on ABA (Cooper, Heron & Heward, 2007). The relapse of problem behaviour following apparently successful treatment has only recently attracted the attention of translational researchers (i.e., researchers evaluating the findings of basic researchers on socially significant problems in applied settings) working in the field of behaviour analysis, although it has been comprehensively evaluated by researchers working with sexually harmful behaviour (Hanson & Morton-Bourgon, 2004) and drug addiction (e.g., Silverman, DeFulio & Sigurdsson, 2012).

Behavioural persistence (i.e., the resistance to change of a behaviour when disrupted by extinction or other condition) was initially evaluated in the field of basic research (i.e., the study of organisms such as rats, pigeons and goldfish in laboratories) because researchers were able to control the reinforcement (e.g., foodstuffs) that maintained behaviour (e.g., Leitenberg, Rawson & Bath, 1970; Leitenberg, Rawson & Mulick, 1975). Basic researchers have since used experiments based on BMT to demonstrate that the persistence of a behaviour is correlated with high rates of reinforcement (e.g., Nevin, Mandell & Atak, 1983).

In classical physics the momentum of a moving body is the product of its mass and velocity (i.e., $M = m \times v$). In the BMT metaphor, the ‘momentum’ of a behaviour is said to be a ‘product’ of its ‘behavioural mass’ and its ‘velocity’. The term ‘behavioural mass’ refers to the resistance to change of a behaviour and ‘velocity’ to its baseline response rate (i.e., the frequency of the behaviour prior to treatment). Using experiments based on BMT, basic researchers have consistently demonstrated that the resistance of a target behaviour of animals (e.g., key pecking, lever-pressing or chain-pulling) was a function of the overall amount of reinforcement in the environment for alternative and target behaviour (Nevin,

Tota, Torquato & Shull, 1990) and not just a function of the amount of reinforcement for the target behaviour.

BMT has inspired a number of translational researchers to examine the effect of differing rates of reinforcement on the resistance of problem behaviour to change (e.g., Ahearn et al., 2003; Mace et al., 2010; Wacker et al., 2011). Importantly for practitioners, what these studies appear to demonstrate is that commonly used reinforcement-based treatment programmes for reducing stereotypy (e.g., Ahearn et al., 2003), disruption (Mace et al., 2010) and aggression and disruption (Pritchard et al., 2014) can make treatment relapse more likely when treatment integrity is compromised in some way.

There are three treatment relapse paradigms: reinstatement, resurgence and renewal. These three paradigms have direct relevance for practitioners working with children and young people with IDD because the relapse of problem behaviour is commonly observed following apparently successful treatment.

Reinstatement

Basic researchers have demonstrated that behaviour can be 'reinstated' following extinction when reinforcement is reintroduced following extinction. Podlesnik & Shahan (2009) trained pigeons in a baseline condition of alternating schedules of low and high rate reinforcement for key pecking for 30 sessions prior to the withholding of food (i.e., extinction) in both schedule components. Responding decreased during extinction but was more resistant to extinction in the high rate component compared to the low rate component. Food was reintroduced when response rates fell below 10% of the baseline response rate for two consecutive sessions in both schedule components. When food was reintroduced in the reinstatement tests in separate response-independent and response-dependent conditions, responding increased compared to the final extinction session. However, the magnitude of relapse was greater in the component with the added time-contingent reinforcers in baseline

and was greater following response-dependent food than following response-independent food.

The relevance of the reinstatement relapse paradigm for practitioners is that it frequently occurs when a child's problem behaviour resumes when reinforcement that had previously maintained problem behaviour is reintroduced post-treatment (Pritchard et al., 2014). For example, practitioners frequently observe this behaviour associated with computers and other similar devices (Mace et al., 2011; Pritchard et al., 2011).

Resurgence

Many basic and applied researchers have shown that a target behaviour can be replaced by an alternative behaviour only for it to reappear when the alternative behaviour is placed on extinction. Doughty & Oken (2008) carried out a selective review which emphasised the importance of a greater understanding the role of resurgence in relapse following treatment for socially significant problems such as drug abuse, communication disorders, and problem behaviours presented by people with IDD such as aggression and disruption.

One of the first researchers to investigate resurgence systematically was Epstein (1983). Epstein trained six naïve pigeons to peck one of two keys to obtain food reinforcement. Key pecking was then extinguished and replaced with an alternative behaviour (e.g., wing raising, head turning etc.). When the alternative behaviour was extinguished key pecking resurged. Resurgence can occur following apparently successful functional communication training (FCT). FCT is a commonly used treatment programme whereby a problem behaviour that a pupil may use to gain attention from a staff member (e.g., a loud vocalisation) is placed on extinction and an alternative behaviour (e.g., raising a hand) is reinforced by the staff member giving attention to the pupil (Fisher, et al., 1993; Volkert,

Lerman, Call & Trosclair-Lasserre, 2009). If the staff member subsequently ignores hand-raising, loud vocalisations will resurge.

Renewal

Renewal experiments have been widely used in basic research to model the relapse of drug and alcohol abuse (e.g., Crombag & Shahan, 2002; Zironi, Burattini & Janak, 2006; Zlebnik et al., 2010). Renewal experiments can take a number of forms. For example, in the most common basic research renewal design (i.e., ABA renewal, where ABA refers to the experimental design, not Applied Behaviour Analysis), a behaviour is established in context A, extinguished in context B and then its persistence evaluated in a return to context A. Other renewal designs used by basic researchers are ABC (i.e., a behaviour is established in context A, extinguished in context B and then evaluated in context C) and AAB (i.e., a behaviour is established in context A, extinguished in context A and any renewal evaluated in context B).

Common examples of renewal in educational settings would include the reintroduction of a teacher, classroom assistant or other support staff who had previously reinforced problem behaviour maintained by escape, attention or access to tangibles even if, following training, they implement the successful behaviour programme with fidelity. For example, a member of classroom staff who had a history of allowing a pupil to escape from academic tasks by removing the task demand when the pupil presented problem behaviour may 'renew' the problem behaviour by their presence (i.e., they are a discriminative stimulus; S^D) because the problem behaviour was previously under stimulus control. Another example of renewal in applied settings is when a pupil's problem behaviour is successfully treated in another setting (e.g., a pupil referral unit) only for it to reappear when the pupil returns to their original school. Lalli, Casey & Kates (1997) describe how they successfully reduced the problem behaviour of three children with IDD who attended their clinic, only to observe the reappearance (i.e., the renewal) of the problem behaviour in two of the three children when

they returned to their homes and school. Lalli et al. speculated that the children's problem behaviour was under the 'stimulus control' of their teacher and parents.

Treatment Integrity

Problem behaviour in children and young people with IDD can relapse because of treatment integrity failures following successful treatment (Allen & Warzak, 2000; Moore & Symons, 2009; St. Peter Pipkin, Vollmer & Sloman, 2010). Maintaining treatment integrity should be an aim of all service providers, but it is unlikely that this will be achieved without systematic staff training (Cullen, 2000; LaVigna et al, 1994; Stokes & Baer, 1977) and rigorous and ongoing monitoring of service delivery (Strohmeier, Mulé & Luiselli, 2014).

To reduce the likelihood of problem behaviours occurring staff in applied settings should use primary prevention strategies such as making access to preferred activities time-contingent on either fixed (FT) or variable-time (VT) schedules (e.g., Hagopian, Wilson & Wilder, 2001; Lalli, Casey & Kates, 1997). Despite these successful treatments, there are still occasions when support staff have to deny children access to what they want because the requested activities are inappropriate or because the child should be attending to academic tasks or self-care skills training. If the child or young person becomes agitated the staff will have to use secondary prevention strategies (e.g., distraction, explanation etc.) to try to prevent the problem behaviour escalating. If these secondary prevention strategies are unsuccessful, problem behaviour may escalate from the initial verbal request and perhaps mild agitation to loud vocalisations followed by disruption and aggression (i.e., take the form of a response class hierarchy; Lalli, Mace, Wohn & Livezey, 1995). These more serious topographies sometimes require staff to use reactive strategies (e.g., physical interventions, as-required medication, seclusion etc.).

Mace et al. (2011) evaluated the effects of three different ways of denying a 13-year-old boy with high-functioning autism access to computer games. Pritchard et al. (2011) later

carried out an extended replication of the Mace et al. study with a 17 year-old male who presented serious aggressive behaviour when denied access to computer games. The results of functional analyses carried out with both boys showed that when staff said 'no', along with an explanation, and denied the boys access to the computer they immediately presented problem behaviour.

An audit of critical incident reports at the residential school where the Mace et al. (2011) and Pritchard et al. (2011) studies were carried out demonstrated that although the strategy was written into the risk assessment and management guidelines for every pupil who presented problem behaviour when denied access to preferred activities, and that all staff had read the documents as part of their training programme, that the strategy was not always implemented correctly. Every year, on average, 35% of all recorded episodes of problem behaviour that occurred in the school were motivated by restricted access to activities. Failures in treatment integrity sometimes resulted in a dangerous escalation in problem behaviour, especially if staff had attempted to use explanations, distraction or extinction. If staff delivered reinforcement for problem behaviour by allowing access to the requested activity the problem behaviour was reinstated. However, as Mace et al. and Pritchard et al. demonstrated, when staff used an appropriate verbal response to engage the child in another activity, or provided the desired reinforcer after a set task had been completed to a satisfactory standard, the relapse of more serious topographies of problem behaviour could be successfully avoided. The final study in this collection reports the results of a staff training programme that demonstrated improvements in treatment integrity following role-play training using standardised scenarios based on incidents of problem behaviour that occurred at the school.

CHAPTER 2¹

TREATMENT RELAPSE AND BEHAVIOURAL MOMENTUM THEORY

The term *treatment relapse* is a generic reference commonly used in medical and mental health fields to describe the re-emergence of some condition that was previously treated successfully (e.g., Hanson & Bussi re, 1998; Stocker, 1998; Ramirez et al., 1989). In the field of Applied Behaviour Analysis, treatment relapse reflects the failure of treatment gains to be maintained when treatment conditions change (Mace & Nevin, in press; Osnes & Lieblein, 2003; Stokes & Osnes, 1989; Nevin & Wacker, 2013). It is a common phenomenon in applied settings that often leads to restrictive treatments and placements (Broadhurst & Mansell, 2007). Our understanding of the nature of treatment relapse has been limited historically. Relapse after successful treatment may occur without warning and for no apparent reason. The field of Applied Behaviour Analysis has treated relapse as a failure to generalize treatment gains over time or across different settings or therapists (Stokes & Baer, 1977). The prescription for the field has been to teach, train, and treat across as many people and settings and over as much time as possible to promote generalization. The applied notion of generalisation is simply a descriptive term that refers to the maintenance of treatment gains when treatment is withdrawn or various contextual variables change; thus, treatment relapse could be considered a lack of generalisation. The problem with the historic behavioural account of relapse as failure to generalise is that it is not grounded in either basic research or experimentally derived theory. As discussed in a later section, developments in basic research (experimental analysis of behaviour; EAB) over the past 30 years have led to an experimentally derived account of treatment relapse that is pointing to a modern treatment of this critically important issue for Applied Behaviour Analysis.

¹ This chapter is adapted from ‘Treatment relapse and behavioral momentum theory’ by Pritchard, D., Hoerger, M. and Mace, F. C. (2014), *Journal of Applied Behavior Analysis*, 47, 814-833, with kind permission of John Wiley and Sons, Inc.

Treatment Relapse and Behavioural Momentum Theory

Behavioural Momentum Theory (BMT) provides an alternative account of treatment relapse (Mace et al., 2010; Nevin, 2002; Podlesnik & Shahan, 2009; Pyszczynski & Shahan, 2011; Shahan & Sweeney, 2011; Sweeney & Shahan, 2013). BMT is based on a metaphor proposing similarity between the momentum of physical objects in motion represented by Newton's (1848) first law of motion and the tendency for reinforced behaviour to persist following disruption of the response-reinforcer relationship (Nevin, Mandell, & Atak, 1983). Nevin and colleagues (Nevin, 1974; Nevin, 1984; Nevin, Tota, Torquato, & Shull, 1990) showed that operant behaviour is comprised of two separable aspects of behaviour that together reflect the strength of the response: baseline response rate and the resistance of baseline response rate to change following a response disruptor. Nevin et al. (1990) found that baseline response rate is a function of the contingency between the response and the reinforcer [i.e., a response-stimulus (R-S) contingency], but resistance to change is a function of the total reinforcement available in a given context, regardless of whether reinforcers are response-contingent or time-contingent (i.e., a stimulus-stimulus (S-S) contingency). According to the metaphor, baseline response rate represents behavioural velocity, and behavioural mass is inferred from the relative resistance to change of this velocity. The BMT account of treatment relapse considers the re-emergence of a target response following treatment such as extinction, differential reinforcement of alternative behaviour (DRA), or time-contingent schedules (TCS)² to reflect the underlying behavioural mass of the target response established by the history with the S-S contingency. Although these concepts appear complex, Nevin (1992) emphasised the importance of resistance to change in practical

² This thesis will use the term *time-contingent schedules* (TCS) because it more accurately describes the procedure commonly described as *non-contingent reinforcement* (NCR) (i.e., the delivery of the reinforcer known to maintain the problem behaviour on a fixed-time or variable-time schedule with the effect of reducing the frequency or intensity of the behaviour; Poling and Normand, 1999).

applications such as teaching academic skills and in decreasing the frequency of problem behaviour. This view was supported by Nevin & Grace (2000) who argued that BMT has implications in the use of clinical interventions for treating problem behaviour.

A commonly used procedure for evaluating resistance to change is to first establish baseline responding in a multiple schedule of reinforcement. The multiple schedule correlates distinct stimuli (e.g., key colours in research with pigeons) with different schedules of reinforcement, known as schedule components, and presents them in an alternating sequence within each training session (e.g. Grimes & Shull, 2001; Igaki & Sakagami, 2004; Nevin et al., 1990; Podlesnik & Shahan, 2009; Pyszczynski & Shahan, 2011). When a stable baseline rate of responding has been established, a response disruptor is then applied to decrease response rate. Common response disruptors include extinction, satiation, dark-key food, alternative reinforcement, and distraction (Mace et al., 1990; Nevin et al., 1983; Nevin et al., 1990). The response rate following disruption is then compared to the baseline response rates, and the difference provides a measure of resistance to change. Baseline response rate and resistance to change can be considered as a mathematical function. The height of the function is the baseline response rate, and the slope of the function signifies the resistance to change in the baseline response rate following different amounts of disruption. To account for any pre-disruption differences in baseline response rates, resistance to change is commonly expressed as a proportion of baseline response rate during varying amounts of disruption. Smaller changes from baseline demonstrate that the behaviour is relatively more resistant to change, whereas larger changes demonstrate that the behaviour is relatively less resistant to change.

Nevin et al. (1990) provided the first evidence that BMT could provide an account of treatment relapse. Nevin et al. conducted two experiments to evaluate the effects of alternative reinforcement on the rate of responding and the resistance of that responding to change. Pigeons' key pecks were reinforced on variable interval (VI) schedules of

reinforcement at equal rates in separate components of a multiple schedule. In one of the components, alternative reinforcement was delivered independent of responding in the first experiment and contingent on a concurrently available target behaviour in the second experiment. Both experiments evaluated how the rate of responding and resistance to change were affected by the overall rate of reinforcement (i.e., the S-S contingency rather than the R-S contingency).

In the first experiment, baseline consisted of a 2-component multiple VI 60-s VI 60-s schedule with additional food delivered in one of the components on a variable-time (VT) schedule in four of seven conditions. During extinction and following pre-session feeding (i.e., satiation) of various amounts of food, resistance to change was greater in the component with added VT reinforcers. The second experiment used a 3-component multiple concurrent schedule with two response keys available in each component. Components were differentiated by key colours to evaluate the effect of reinforcement of an alternative response (i.e., pecking on a separate key) on the resistance to change of the target response. The first component was analogous to DRA, and it arranged three times more reinforcement for the alternative response than for the target response. The target behaviour alone was reinforced in the second and third components; in the second component, the target behaviour was reinforced at the same rate as in the DRA component, whereas in the third component, the target behaviour was reinforced at the same rate as the combined alternative and target rate in the DRA component. Thus, the R-S contingencies for the target behaviours were the same for components 1 and 2, but the overall rates of reinforcement correlated with key colours (the S-S contingency) were the same in components 1 and 3. Responding was disrupted with extinction and satiation, and resistance to change was greater and similar in components 1 and 3.

The significance of Nevin et al.'s (1990) findings for suggesting a BMT account of treatment relapse is that both experiments employed analogues of common behavioural treatments for target behaviours: Non-contingent reinforcement in Experiment 1 and DRA in Experiment 2. Both procedures resulted in greater resistance to change despite having a response-reducing effect during baseline. This research exposed the paradoxical effect of TCS and DRA being effective treatments while concurrently increasing the persistence of the target response during extinction. Extinction in this case is analogous to the cessation of treatment, which is a common cause of treatment relapse (Mace & Nevin, in press; Wacker et al., 2011).

The finding that resistance to change is a function of S-S contingencies, or the overall reinforcement available in a given context, has been shown to be highly robust. The finding has been replicated with a variety of non-human species, including pigeons (Nevin, Grace, Holland, & McLean, 2001), rats (Harper, 1999; Mauro & Mace, 1996), and goldfish (Igaki & Sakagami, 2004). The finding also holds using qualitatively different reinforcers (Grimes & Shull, 2001; Mace, Mauro, Boyajian, & Eckert, 1997; Shahan & Burke, 2004), single versus variable reinforcers (Milo, Mace, & Nevin, 2010), and ratio and interval schedules of reinforcement (Leitenburg, Rawson, & Mulick, 1975). There have also been numerous translational research studies with humans that have replicated the finding. Dube, Ahearn, Lionello-DeNolf, and McIlvane (2009) reviewed the basic and applied literature and confirmed that resistance to change is a function of the overall rate of reinforcement in a stimulus context and that it is a robust phenomena across species. However, there have also been some failures to replicate. For example, Podlesnik & Shahan (2008) used pigeon subjects to investigate how degrading the response-reinforcer relation with response-independent or unsignaled delayed reinforcement affects resistance to change. In one experiment Podlesnik and Shahan found that behaviour maintained by a proportion of

response-independent or delayed reinforcement was more sensitive to disruption than behaviour maintained by equal rates of reinforcement, a finding that is counter to BMT. Finally, tests of resistance to change in human studies have shown mixed results when different forms of disruptors were used. Lionello-DeNolf, Dube, and McIlvane (2010) found differences in multiple schedule components during resistance-to-change tests using an alternative distracting stimulus and having an experimenter in the room during tests only. Pre-feeding and movie distraction produced mixed results across participants.

Applications of BMT Paradigms of Treatment Relapse

Translational research is said to ‘bridge’ the gap between basic and applied behavioural research by utilizing knowledge gained from basic research to develop behavioural technologies needed to address human behavioural needs (Mace & Critchfield, 2010). The translational research described below and in later sections of this chapter illustrates (a) that basic BMT research predicts an unwanted side effect of behavioural treatments based on alternative reinforcement; (b) the three BMT paradigms of treatment relapse may predict clinically relevant behaviour in similar contexts; and (c) BMT has inspired modifications to behavioural treatments that are designed to avoid or minimize the magnitude of treatment relapse.

Mace et al. (2010) investigated the proposition that DRA could increase the resistance of problem behaviour to extinction in clinical cases, as implicated by Nevin and colleagues’ (1990) work with pigeons (see Mace, 2000, and Mace et al., 2009, for initial summaries). Three children with intellectual disabilities and problem behaviours were exposed to three conditions in varied orders: (a) a functional analysis (FA) baseline, in which problem behaviour was reinforced on a variable ratio, variable interval, or continuous reinforcement (CRF) schedule; (b) DRA, in which alternative, pro-social behaviour was reinforced at a rate of 165% to 195% of baseline while concurrently reinforcing problem behaviour at baseline

rates (in order to replicate Experiment 2 from Nevin et al., 1990), and (c) extinction, in which baseline and DRA reinforcement was withheld. The results for all three children showed that extinction took much longer to occur following the DRA condition than following baseline reinforcement only. Volkert, Lerman, Call, and Trosclair-Lasserre (2009) found similar resumption of problem behaviour during extinction following successful treatment with functional communication training (FCT), although it was not clear whether there were differences in reinforcement rates in the FA baseline and FCT treatment.

Ahearn, Clark, Gardenier, Chung, and Dube (2003) reported similar unwanted effects of VT toy deliveries to treat stereotypy in three children with autism. FA results were consistent with each child's stereotypic behaviour being maintained by automatic reinforcement. The persistence of each child's stereotypic behaviour was evaluated by presenting each child with a preferred object independent of stereotypic behaviour, then presenting an alternative object in an attempt to disrupt the behaviour. The level of each child's stereotypic behaviour was measured during three experimental conditions (baseline, VT access to a preferred object, and the test condition). No preferred object was available during baseline, a preferred object was available during the VT condition, and a different preferred object was available continuously during the test condition. Although the results demonstrated that the level of stereotypy was reduced by VT access to preferred objects, the persistence of stereotypy subsequently increased in the test condition when VT access to preferred objects preceded the test condition relative to baseline preceding the test condition. The Mace et al. (2010) and Ahearn et al. translational studies are noteworthy because they exposed an unwanted and unanticipated side effect of alternative reinforcement treatments of problem behaviour that were predicted by basic BMT research; in clinical cases, this side effect could be conceptualized as treatment relapse (Nevin et al., 1990).

Although the focus of this review is on the BMT account of treatment relapse, other variables and theoretical perspectives have contributed significantly to the basic research on the major paradigms of treatment relapse. These findings will be noted in the relevant relapse paradigm discussions in a following section. The primary purpose for emphasizing the BMT account is threefold. First, treatment relapse following behavioural interventions based on alternative reinforcement can be attributed in many cases to a lack of treatment integrity. Much of the basic BMT relapse research has employed procedures that are analogues to treatment integrity failures. Second, BMT has inspired clinical translational research that is consistent with its theoretical predictions. Third, BMT predicts potential solutions to the problem of treatment relapse that have been supported by a limited number of clinical translational studies. Before discussing the major treatment relapse paradigms, we will briefly review behavioural treatments based on alternative reinforcement and common types of treatment integrity failures.

Alternative Reinforcement Treatments and Integrity Failures

Treatments employing alternative reinforcement have a long history of successful treatment of the behaviour of people with intellectual disabilities (Chowdhury & Benson, 2011). Three variations of alternative reinforcement have become mainstay approaches to function-based treatments of problem behaviour: DRA, differential reinforcement of other behaviour (DRO), and TCS. Contemporary applications of DRA involve reinforcing a pro-social alternative behaviour that serves the same function as problem behaviour, sometimes in conjunction with withholding reinforcement for the problem behaviour (i.e., extinction) (Fisher et al., 1993). DRO involves delivering reinforcement after a specified period of time has elapsed without the occurrence of problem behaviour (Lindberg, Iwata, Kahng, & DeLeon, 1999). TCS arranges the functional reinforcer (i.e., the reinforcer shown to maintain problem behaviour) to be delivered independent of any behaviour and contingent on the

passage of time. Reinforcers are delivered according to time schedules that are either fixed-time (FT) or VT, although Carr et al. (2000) note that these schedules are more likely to be more accurately and consistently used in clinical settings where procedures are more easily controlled than in naturalistic settings (e.g., schools and family homes).

Maintaining the effectiveness of DRA, DRO, and TCS depends, in large measure, on maintaining treatment integrity; that is, ensuring that the procedures (e.g., motivating conditions, contingencies, and schedules) shown to produce a clinical effect are implemented accurately and consistently. Lapses in treatment integrity can be attributed to a variety of factors including withdrawal of the intervention deliberately (Lieving, Hagopian, Long, & O'Connor, 2004; Mace et al., 2010; Vollmer, Roane, Ringdahl & Marcus, 1999), inadvertently, or when the participant is re-exposed to contexts correlated with reinforcement of problem behaviour (Allen & Warzak, 2000). Inadvertent lapses in treatment integrity can occur in applied settings due to, for example, caregiver distraction, staff turnover, staff shortages, and poorly trained caregivers or staff (Whitworth, Harris, & Jones, 1999).

Several studies have examined how much treatment integrity and what aspects of treatment are necessary to maintain treatment effects and avoid treatment relapse. For example, Northup, Fisher, Kahng, Harrell, and Kurtz (1997) evaluated the impact of different percentages of DRA and time out on the problem behaviour of three participants with intellectual disabilities. Caregivers for all three participants reported concern that they did not have the time or ability to deliver the interventions as prescribed. Results demonstrated that treatment effects for two of the participants could be maintained when both interventions were implemented at 50% of the initial recommended amount. The time out component for the third participant could be implemented at 25% of the initial recommended amount provided that the concurrent DRA intervention was implemented as designed. Vollmer et al. (1999) parametrically varied levels of treatment integrity for three youths with problem

behaviours to determine the point at which treatment relapse occurred. Treatment integrity was defined as the relative proportion of appropriate behaviour that was reinforced versus the proportion of problem behaviour that was reinforced. Baseline consisted of reinforcement of 100% of problem behaviours and 0% of appropriate behaviours (100/0). Full treatment integrity consisted of 0/100 reinforcement proportion, and lapses in treatment integrity included a 50/50 and 25/75 proportion. Results showed that treatment effects could be maintained when 50% of both problem and appropriate behaviour were reinforced. Mace and Lalli (1991) and Mace et al. (2008) used TCS at various schedule values to reduce problem behaviour maintained by attention. In both instances, treatment effects were lost when time-contingent attention was delivered at rates that were too low, which is analogous to a lapse in treatment integrity.

St. Peter Pipkin, Vollmer, and Sloman (2010) examined the effects of two types of DRA integrity failures, both alone and in combination, using a computer-based analogue to DRA and with children with problem behaviours in a clinical setting. Omission failures occur when the DRA reinforcer is not delivered according to the prescribed schedule, whereas a commission failure is the resumption of reinforcement of problem behaviour. St. Peter Pipkin et al. found that commission errors alone and a combination of commission and omission errors led to greater treatment relapse than omission errors alone. These effects were most pronounced when treatment integrity dropped to 40%. The above studies are important because if treatment effects can be maintained at comparatively low rates of reinforcement, they are more likely to be implemented by parents and other caregivers (Moore & Symons, 2009).

Paradigms of Treatment Relapse: Reinstatement, Resurgence and Renewal

Reinstatement, resurgence and renewal are three treatment relapse paradigms derived from basic research. *Reinstatement* of previously extinguished behaviour occurs when the

reinforcer maintaining baseline response rate is delivered either time-contingently or contingent on a target response following extinction, resulting in a resumption of responding of the previously extinguished target response (Podlesnik & Shahan, 2009; Shaham, Shalev, Lu, de Wit, & Stewart, 2003). *Resurgence* is defined as the reappearance of a behaviour that has previously been eliminated by extinction and DRA when the alternative behaviour itself is placed on extinction (Doughty & Oken, 2008). *Renewal* occurs when baseline responding is placed on extinction in a context different from baseline even though the baseline discriminative stimuli remain in effect. Responding then recurs when the baseline context is replicated despite ongoing extinction (Bouton, 2004; Grimes & Shull, 2001; Nakajima, Tanaka, Urushihara, & Imada, 2000). In all three paradigms, the magnitude of treatment relapse is greater in the schedule component with the higher rate of baseline reinforcement. Reinstatement and resurgence are analogues of treatment integrity failures (omission and commission errors; see St. Peter Pipkin et al., 2010), and renewal is analogous to conducting treatment in a clinical setting and returning to the home or school environment where problem behaviour had been reinforced but the treatment package remains in effect (e.g., Lalli, Casey, & Kates, 1997). Lalli et al. reported that problem behaviour presented by three participants had been successfully treated by therapists, but recurred in two participants on the introduction of parent and teacher training despite treatment procedures being implemented correctly. Lalli and colleagues speculated that the problem behaviour was under stimulus control (i.e., the participants' parents and teacher were stimuli that signalled the likelihood that problem behaviour would be reinforced).

We will distinguish among each of these relapse paradigms, beginning each section with a summary of the three experiments by Podlesnik and Shahan (2009). The Podlesnik and Shahan paper is a convenient illustration of the three paradigms because all three tests had identical baseline procedures. We will then broaden the discussion to updates and

extensions to the BMT account of treatment relapse, briefly review experiments evaluating variables that influence relapse other than the S-S contingency (non-BMT paradigms), and conclude each section with a discussion of available translational research studies.

Podlesnik and Shahan's (2009) subjects in each experiment were 10 homing pigeons maintained at 80% of their free-feeding weight. A row of three response keys was on the operant panel above a food hopper. Pecks to the centre key produced reinforcers according to programmed schedules. Each peck resulted in a brief flicker to a chamber houselight. All illumination terminated during operation of the food hopper. The baseline condition common to all three relapse models consisted of equal VI 120-s schedules arranged in a multiple schedule with time-contingent food added to one component on a VT 20-s schedule.

Reinstatement. Pigeons were trained in the baseline condition described above for 30 sessions prior to the withholding of food (i.e., extinction) in both schedule components. Responding decreased during extinction but was more resistant to extinction in the VI 120-s VT 20-s component compared to the VI 120-s component. Food was reintroduced when response rates fell below 10% of the baseline response rate for two consecutive sessions in both schedule components. When food was reintroduced in the reinstatement tests in separate response-independent and response-dependent conditions, responding increased compared to the final extinction session. However, the magnitude of relapse was greater in the component with the added time-contingent reinforcers in baseline and was greater following response-dependent food than following response-independent food.

BMT-based reinstatement has also been used in drug addiction research. Pyszczynski and Shahan (2011) exposed rats that were trained to lever press to self-administer ethanol to an equal, two-component, VI 15-s multiple schedule using ethanol as the reinforcer in a baseline phase. In one of the components, response-independent food was delivered on a VT 120-s schedule. Following baseline, extinction was implemented, in which all reinforcers

were discontinued while the discriminative stimuli continued to alternate as in the multiple schedule baseline. After responding decreased to 10% of baseline, reinstatement consisted of response-independent ethanol delivered at 2 s and 8 s into the first component of the session. Responding resumed in both components during reinstatement but to a greater extent in the component with added non-drug reinforcers. The significance of this finding is that relapse occurred using qualitatively different reinforcers, a situation that parallels clinical settings.

Non-BMT paradigms. Reid (1958) reported one of the first experimental demonstrations of reinstatement with rats, pigeons, and college students using a similar experimental procedure. In baseline for the nonhuman subjects, food was provided on an FR1 schedule for the rats and pigeons following lever presses and key pecks, respectively, followed by a standard extinction procedure. When responding extinguished, a single response-independent food was delivered early in the session, and responding resumed briefly for most subjects. The college students were divided into two groups. Their task was to insert counters into a slot machine to acquire as many counters as possible by the end of the session. Baseline reinforcement was on an FR1 schedule for one group and a VR2 schedule for the other group, with reinforcers being two or four counters per reinforcement for the respective schedules. Extinction sessions followed baseline until counter insertions were extinguished. In the final extinction session, free counters were provided, and once again responding resumed for most participants. Reid emphasised the disinhibiting effect that response-independent reinforcers may have after extinction of operant behaviour.

Spradlin and colleagues (Spradlin, Girardeau, & Hom, 1966; Spradlin, Fixsen, & Girardeau, 1969) reported similar reinstatement effects with children with intellectual disabilities. Spradlin et al. (1966) established baseline plunger-pulling responses for token reinforcers exchangeable for various commodities on an FR 50 schedule of reinforcement. Following stable, high-rate responding, extinction was imposed until a large inter-response

time criterion was met. Some extinction sessions were followed by the delivery of a single token, whereas other extinction sessions were followed by no stimulus change as a control procedure. Spradlin et al. (1969) refined their procedure during reinstatement to provide either food reinforcers, a novel stimulus (buzzer), or no stimulus change. Re-emergence of responding in both studies was greatest in the food reinstatement; the buzzer control procedure had small reinstatement effects.

Franks and Lattal (1976) approached reinstatement by producing different response rates in rats using different schedules at separate times during training. A VR 20 schedule resulted in high response rates, and a differential reinforcement of low rate responding (DRL) 30-s schedule produced low response rates. Following extinction, a phase of FT 30-s food deliveries tested for reinstatement. During the FT reinstatement phase, response rates were much higher following the VR-20 training than the DRL 30-s training. Franks and Lattal (1976) and Spradlin et al. (1966; 1969) attributed the reinstatement of responding to the discriminative properties that reinforcers acquire during training (see also Winterbauer & Bouton, 2011, for an account of the mechanisms involved in resurgence).

Reinstatement in cocaine-addicted rodents has also been examined on a single response in the presence or absence of an enriched environment during extinction. Solinas, Chauvet, Thiriet, El Rawas, and Jaber (2008) conditioned mice to cocaine in a standard environment (SE) for 5 days. Afterwards, half of the mice remained in the SE, while the other half were placed in an enriched environment (EE) during extinction. When the EE mice were returned to the SE after 30 days of EE, renewal effects were absent following cocaine priming (time-contingent cocaine). Zlebnik, Ander, Gliddon, and Carroll (2010) first trained rats to use a running wheel and then later to self-administer cocaine. A saline solution replaced cocaine during extinction, and cocaine priming followed extinction. Varying degrees of access to the wheel were arranged during extinction and reinstatement. Reinstatement

effects were lower in groups that had access to the wheel either during extinction only or during both extinction and reinstatement. Much greater reinstatement was observed in groups for which the wheel was locked either during extinction only or during both extinction and reinstatement. If these findings translate to clinical situations, it suggests the importance of an enriched environment (i.e., alternative reinforcement) during extinction and a limitation of time-contingent access to the reinforcer maintaining problem behaviour.

Clinical translations. DeLeon, Williams, Gregory, and Hagopian (2005) provided a preliminary evaluation of the effects that post-extinction FT reinforcers can have on behaviour. An FA showed that the problem behaviour of an individual with intellectual disabilities was maintained by adult attention. Following the FA, the individual was exposed to the following three conditions. During baseline, a therapist provided verbal attention following each occurrence of problem behaviour. In the next condition, extinction, all problem behaviour was ignored, resulting in near zero occurrences of the target responses. During the third condition, the therapist delivered brief physical attention on an FT 60-s schedule while ignoring problem behaviour. Problem behaviour immediately recurred, albeit at a lower frequency than baseline. Although the study lacked experimental control, the results are predicted by the BMT paradigm of reinstatement.

The only controlled clinical study that employed reinstatement procedures similar to Podlesnik and Shahan (2009) is Pritchard, Hoerger, Mace, Penney, and Harris (2014). Pritchard and colleagues reinforced the problem behaviour of a 16 year-old male with severe intellectual disabilities during an FA baseline in a multiple VI 60-s VI 60-s schedule with different therapists correlated with the two components. Baseline showed problem behaviour was maintained by attention. Treatment delivered by both therapists consisted of either prompts to use a communication card for attention or time-contingent attention. However, the rate of attention for therapist 1 was four times greater than for therapist 2 during treatment.

Following successful treatment, the FA baseline was reinstated with equal rates of reinforcement for both therapists (contingent reinforcement reinstatement, Podlesnik & Shahan, Experiment 1). Baseline FA procedures resulted in equal rates of problem behaviour. Treatment was effective for both therapists despite differences in reinforcement rates; however, when baseline conditions were reinstated, relapse was 2.6 times greater in the presence of the therapist implementing the higher-rate reinforcement treatment.

Resurgence. The resurgence experiment conducted by Podlesnik and Shahan (2009) started with 35 sessions of the baseline condition described above followed by an extinction condition in which all food deliveries were discontinued. During extinction, the centre key light remained on and the right key was illuminated. The first response on the right key was reinforced, and then right key pecks were reinforced on a VI 30-s schedule throughout extinction (i.e., DRA). After response rates on the centre key had fallen to less than 10% of baseline in both components during extinction, the resurgence test was implemented by stopping food reinforcement on the right key while the key light remained illuminated. The results showed that responding was more persistent in the baseline component with rich reinforcement compared to the lean component. These results not only support previous findings that the resistance to change of behaviour is a positive function of the overall rate of reinforcement in the stimulus context (e.g., Nevin et al., 1990; Podlesnik & Shahan, 2009: Experiment 1) but also suggest that interruption of reinforcement of alternative behaviour will result in greater treatment relapse in contexts correlated with higher baseline rates of reinforcement.

Podlesnik, Jimenez-Gomez, and Shahan (2006) reported resurgence in alcohol-seeking behaviour in four rats. In baseline, rats were trained to self-administer alcohol via lever pressing on a random-ratio-25 schedule of reinforcement. Next, alcohol presentations were withdrawn for lever pressing, but pulls on a chain were reinforced with food on a

random-ratio-10 schedule of reinforcement. When food pellets for chain pulls were then discontinued, lever pressing to obtain alcohol recurred. Quick, Pyszczynski, Colston, and Shahan (2011) replicated these findings employing similar procedures but used cocaine instead of alcohol as the baseline reinforcer. Together, these findings indicate that DRA using an arbitrary reinforcer unrelated to maintenance of problem behaviour will also result in treatment relapse if DRA is interrupted.

Sweeney and Shahan (2013) compared the effects that high-rate DRA (VI 10-s), low-rate DRA (VI 100-s), and a thinning DRA (daily 10-s increases in VI [10 to 100 s]) had on resurgence. High-rate DRA resulted in greater suppression of target lever pressing in rats than low-rate or thinning DRA but resulted in greater relapse on the target lever during the resurgence test. Low-rate and thinning DRA resulted in no relapse when the target and alternative responses were placed on extinction. These results are promising for applied behaviour analysts who may design DRA treatments with low-rate or thinning-rate DRA to avoid treatment relapse when the integrity of DRA is compromised (see translational studies below).

Shahan and Sweeney (2011) developed a quantitative model of resurgence based on BMT. The model is an extension of quantitative models previously advanced by Nevin, McLean, and Grace (2001), Nevin and Grace (2000), and Podlesnik and Shahan (2008; 2009). The model provides a fuller account of the factors that contribute to the magnitude of resurgence following DRA. It includes parameters that indicate that added sources of reinforcement (both time- and response-dependent) have the dual effects of both adding reinforcement to the context and functioning as an added disruptor to the target response. The model further accommodates the findings that the rate of alternative reinforcement and time in alternative reinforcement and extinction affect resurgence. That is, the magnitude of the disruptive impact of alternative reinforcement depends on DRA reinforcement rate and

the amount of time spent in DRA prior to extinction plus the duration of extinction. Nevin & Shahan (2011) provide a further series of quantitative models based on BMT that can be used to evaluate resistance to change. Resurgence was evaluated by modelling the effects of disruptors, showing that the effects of alternative reinforcement may be analogous to disruption (e.g., distraction by video in applied studies). Nevin & Shahan's Equation 7 can be used to predict many of the findings made by both basic and applied researchers (e.g., that longer exposure to extinction and extended DRA treatment reduces the magnitude of resurgence) which should be taken into account when clinicians design interventions.

Non-BMT paradigms. Numerous studies have been published on resurgence without appealing to the importance of the S-S contingency in BMT. Most, but not all, of these studies used the standard three-phase experimental procedure described above, in which Phase 1 reinforces a target response, Phase 2 jointly reinforces an alternative response and extinguishes the target response, and Phase 3 places both the target and alternative responses on extinction. Leitenberg and colleagues (Leitenberg, Rawson & Bath, 1970; Leitenberg et al., 1975) were the first to experimentally demonstrate resurgence with rats. Leitenberg et al. (1970) found resurgence of target bar pressing when alternative bar pressing was placed on extinction. Epstein (1985) and Lieving and Lattal (2003) replicated Leitenberg et al.'s (1970) findings with pigeons.

Leitenberg et al. (1975) found that the magnitude of resurgence was greater for a topographically similar alternative response to the target response (bar press) than to a topographically dissimilar response (tube lick). They also found the effects were similar for FR schedules and yoked VI schedules for the alternative response, resurgence was greater for high-rate compared to low-rate alternative reinforcement, and resurgence magnitude was related to the duration of alternative reinforcement, with shorter durations yielding greater resurgence. The authors speculated about two theoretical accounts (i.e., the response

prevention hypothesis and the discriminative cue hypothesis) for their findings but did not reach any firm conclusions.

Epstein (1983) used a four-phase procedure to examine resurgence in pigeons: (1) baseline reinforcement of the target key, (2) extinction of the target key, (3) reinforcement of a topographically dissimilar alternative (e.g., wing raising) with concurrent extinction of the target key, and (4) extinction for all responses. Epstein found that wing raising decreased in the second extinction phase and key pecking re-emerged. Winterbauer and Bouton (2011) used Epstein's procedures and concluded that resurgence of the initial target response occurs following extinction of the alternative response because presentation of food reinforcers in the third phase sets the occasion for the original target response to occur during the fourth phase (i.e., during extinction).

One clinical implication is that reinforcement of topographically dissimilar responses (DRA) can still lead to relapse even if the target problem behaviour has been previously extinguished prior to alternative reinforcement. This suggests that extinguishing problem behaviour first before introducing DRA may not be a solution to treatment relapse. One implication for clinical situations is that discontinued reinforcement of an alternative behaviour can be concurrent with the resurgence of a previously extinguished problem behaviour.

Several studies have supported the conclusion that response rate is as important a predictor of relapse as the S-S reinforcement rate (Doughty, Reed, & Lattal, 2004; Okouchi & Lattal, 2006; Reed & Doughty, 2005). For example, Reed and Morgan (2007) provided baseline lever press training with rats using a multiple DRH DRL schedule, which produced large differences in response rates favouring the DRH component. This phase was followed by a multiple VI 60-s VI 60-s schedule, which lasted until the difference in response rates from the previous phase was eliminated. During the extinction phase, resurgence was

markedly greater on the lever that had been previously correlated with the DRH schedule and high response rates. At present, the quantitative model developed by Shahan and Sweeney (2011) discussed earlier does not accommodate response rates into the model. However, if the model evolves to include a response rate parameter, this may promote integration of BMT and response rate accounts.

Our review of non-BMT resurgence research is not exhaustive. However, excellent reviews are available by Lattal and St. Peter Pipkin (2009) and Doughty and Oken (2008). Both reviews highlight the implications of resurgence in treatment relapse and the importance of its continued investigation by basic and applied researchers.

Clinical translation. Although there have been a few studies that have demonstrated resurgence in target responding following treatment or extinction (e.g., Lieving et al., 2004; Mace et al., 2010; Volkert et al., 2009), only two clinical translations compared resurgence following different rates of reinforcement during treatment. Parry-Cruwys et al. (2011) reinforced task engagement for six children with various disabilities according to a multiple VI 7-s VI 30-s schedule with components differentiated by different tasks. Following baseline, task engagement was disrupted with a distracting stimulus (e.g., toys, videos) while baseline reinforcement remained in place. Distraction disrupted responding more in the component with leaner rates of reinforcement for task engagement for five of six children.

Pritchard et al. (2014) also performed a resurgence test in the last phase of the study described in the reinstatement section above. After the reinstatement phase, treatment was reimplemented at different rates of reinforcement (4 to 1 ratio). A single session of extinction was then conducted separately by the two therapists until target problem behaviours remained at zero for five consecutive minutes. Relapse was 2.2 times greater in the presence of the therapist who implemented the treatment with the higher rate of reinforcement.

The findings of Parry-Cruwys et al. (2011) and Pritchard et al. (2014) suggest that treatments with high-rate reinforcement carry the risk of higher relapse magnitudes if treatment integrity is significantly compromised.

Renewal. Podlesnik and Shahan's (2009) ABA renewal experiment began with 80 sessions of the same baseline condition used in their reinstatement and resurgence experiments as described above. A steady houselight (i.e., Context A) remained on during all baseline sessions. The extinction condition followed, during which the houselight flickered on and off at a rate of 0.1-s (i.e., Context B) and food reinforcement was stopped in both the VI 120-s (i.e., lean) and VI 120-s VT 20-s (i.e., rich) components. After responding had fallen below 10% of baseline, the steady houselight was reintroduced in the renewal test (i.e., a return to Context A), and extinction remained in effect. The results demonstrated that responding was more persistent during extinction in the rich component compared to the lean component and that renewal was greater during the rich component compared to the lean component. The renewal model of relapse supports previous findings that the persistence of behaviour is dependent on the overall rate of reinforcement in the stimulus context, even when the reinforcement is delivered independently of the response (e.g., Nevin et al., 1990; Podlesnik & Shahan, 2009, Experiments 1 & 2).

There are numerous examples of ABA renewal in the basic research literature; however, none of them explicitly employ procedures highly similar to Podlesnik and Shahan (2009) nor do they appeal to a BMT account of the results. For example, Nakajima et al. (2000) trained rats to press a single lever in two contexts (A and B) that differed along several variables: size of chamber, auditory vs. visual stimuli, floor composition, and the presence of a chain suspended from the ceiling. Baseline was established in context A, in which a VI 30-s VT 30-s schedule was operative for lever presses. Following baseline, lever pressing was placed on extinction in context B. After lever pressing had extinguished in

context B, rats were returned to context A with a continuation of extinction. A transient renewal effect was observed with a return to context A.

Bouton, Todd, Vurbic, and Winterbauer (2011) replicated the ABA renewal effect with rats using an initial VI 30-s schedule for lever presses. In addition, they examined two variations of the renewal paradigm. The AAB renewal procedure reinforces lever presses in the initial (A) baseline, again on a single schedule rather than a multiple schedule where reinforcement rates in the two components differ (cf. Podlesnik & Shahan, 2009). Extinction followed the initial baseline in the same context (A) and a different context (B). The rats exposed to the AAB renewal sequence showed a renewal effect in the B context test. However, the magnitude of the effects was significantly less than the test in the ABA sequence. The second variation was the ABC sequence, in which C represents a second context that differed from the training context A. Following extinction in context B, rats were exposed to a novel context (C) while extinction remained in place. Renewal effects were observed in the C context test but were of a magnitude that was far lower than the ABA sequence and comparable to the AAB sequence. Todd, Winterbauer, and Bouton (2012) found that the magnitude of renewal effects was positively related to the amount of acquisition training and the point at which acquisition occurred in multiple contexts, suggesting that extensive reinforcement histories can accentuate renewal effects.

Nakajima, Urushihara, and Masaki (2002) examined ABA renewal using training procedures that simulate common applied behaviour analytic treatments for problem behaviour in lieu of extinction, which is commonly used in the B phase. Following baseline reinforcement of lever presses in Experiment 1, omission training, or DRO 30 s, was introduced in context B to eliminate responding. After responding was eliminated by DRO, rats were returned to context A while the DRO contingency continued. A clear and transient renewal effect was observed, similar to Nakajima et al. (2000). In Experiment 2, context B

employed time-contingent food to reduce lever pressing. After responding was reduced markedly (but not eliminated) in context B, a return to context A with time-contingent food produced a similar transient renewal effect. The applied significance of these experiments is that DRO and TCS are common behavioural interventions. These findings suggest translation of these experiments with clinical populations may expose a side effect of these two interventions (cf. Mace et al., 2010).

This section concludes by noting two studies by Winterbauer and Bouton (2010; 2012) in which the authors argued that the typical resurgence paradigm discussed earlier (reinforcement → reinforcement of an alternative response plus extinction of the original response → extinction of both responses) is best interpreted as a renewal effect. Winterbauer and Bouton (2010) conducted the classic resurgence studies and contended that the reinforcement provided in Phases 1 and 2 occur at identical rates, and the difference between the phases is the upshift and downshift in the rates of reinforcement for response 1 and response 2. They argued that these shifts are best considered changes in context and are more representative of a renewal paradigm. Winterbauer and Bouton (2012) compared the typical resurgence arrangement with a condition in which reinforcement for the alternative response in Phase 2 was thinned prior to extinction of both responses. Thinning reduced the magnitude of “resurgence” compared to an immediate shift from alternative reinforcement to extinction; however, responding to the first lever did return during the extinction test following thinning (cf. Sweeney & Shahan, 2013).

Non-BMT paradigms. There are two lines of renewal research that are outside the BMT model. The first examines renewal effects following an analog to treatment for drug abuse and addiction. For example, Crombag and Shaham (2002) trained rats to self-administer a heroin-cocaine mixture in context A and then extinguished lever pressing in context B. A return to the original context A with extinction remaining in effect produced a strong renewal

of lever pressing. Zironi, Burattini, Aicardi, and Janak (2006) replicated these findings using very similar procedures with alcohol as the reinforcer. The applied implication is that returning an individual to the original addiction context following treatment for addiction in a separate context may lead to treatment relapse despite continued use of treatment protocols (e.g., self-management or support groups).

The second line of research demonstrates a renewal effect on respondent behaviour. The conditioning procedure consists of presenting an unconditioned stimulus (US; shock) with a conditioned stimulus (CS; geometric shapes, for example) in context A. This procedure is followed by respondent extinction where the CS is presented in the absence of the US. Denniston, Chang, and Miller (2003) found that respondent conditioning interrupted licking of fluid-filled tubes in rats. In Context B, groups of rats were exposed to either a moderate or large number of extinction sessions. When returned to Context A or exposed to a novel context C with CS presentation alone, renewal effects were much lower in the group that received a large number of extinction sessions. These findings have been replicated with humans using shock as the US (Bandarian Balooch & Neumann, 2011) and using video games with adverse events as the US in both the ABA and ABC renewal paradigms (Nelson, Sanjuan, Vadillo-Ruiz, Pérez & León, 2011; Neumann, 2006).

Clinical translation. To date, there have been no clinical translational studies examining the renewal paradigm of treatment relapse (but see Chapter 4). Several basic research studies discussed above hold promise for clinical translation. When treatment occurs in a different setting from the one in which problem behaviour was originally reinforced, a return to the original setting following successful treatment may well occur (Lalli, Casey, & Kates, 1997). Because this is inherent to clinic-based treatment, translational studies are important.

BMT Inspired Solutions to Treatment Relapse

The studies above illustrate that basic BMT research predicts how individuals with intellectual disabilities and problem behaviour will behave when DRA or TCS treatments are followed by lapses in treatment integrity (e.g., failure to provide alternative reinforcement, extinction), reinstatement of baseline reinforcement of problem behaviour, or a change from a treatment context to a baseline context. In addition to predicting different types of treatment relapse, BMT has also inspired some possible solutions to the problem.

The key reason that DRA and TCS treatments can increase the persistence of problem behaviour and lead to treatment relapse is that these treatments ordinarily *add* reinforcers to the same environment in which problem behaviour is or has been reinforced. These added reinforcers increase the stimulus-reinforcer (S-S) contingencies responsible for resistance to change in BMT accounts of treatment relapse (i.e., behavioural mass, Nevin et al., 1990). Mace et al. (2010) reasoned that it may be possible to reduce or avoid the persistence strengthening effects of DRA by training the alternative response (e.g., communication) in a context separate from that correlated with reinforcement of problem behaviour. After the alternative response is well established in the separate context, stimuli correlated with the alternative response can be introduced to the context in which problem behaviour requires treatment. This procedure separates the context-reinforcer contingencies for the alternative behaviour and problem behaviour. The hypothesized result is that by separating the context-reinforcer contingencies, DRA would not add reinforcers to the context in which problem behaviour is treated.

Mace et al. (2010) examined this premise first by developing a rat model of the procedure and then translating the laboratory procedure into a clinical arrangement to be tested with children with behaviour disorders. The rat model was tested with four rats exposed to a baseline 3-component multiple concurrent schedule. Each component (C) was

correlated with different jewelled lighting above the two response levers (C1, slow flicker; C2, fast flicker; C3, constant light). The right and left levers represented a target problem behaviour and alternative behaviour, respectively. C1 arranged 24 food pellets per hour on the right lever and no reinforcement for the left lever, for which the jewelled light was dark. This modelled reinforcement of problem behaviour only. C2 modelled DRA and provided 24 pellets/hr on the right lever and 96 pellets/hr on the left lever. C3 arranged 96 pellets/hr on the left lever and none on the right lever, which had a dark jewelled light. This component represented training an alternative response in a separate context from that in which problem behaviour is reinforced. Extinction followed this baseline condition, and the discriminative stimuli for C1 and C2 remained identical to baseline. However, the discriminative stimuli in C3 were a compound of discriminative stimuli from the baseline C1 and C3 conditions. That is, above the right lever was a slow flicker light and above the left lever was a constant light. This arrangement modelled introducing the alternative behaviour context to the treatment of problem behaviour context. Results of the extinction test showed that resistance to change (or treatment relapse) was greatest in C2. For two rats, resistance to extinction was lowest in C1 (with no added S-S contingencies) and, for the other two rats, responding during extinction was comparable in C1 and C3. Thus, in this rat model, training an alternative behaviour in a separate context either avoided increased resistance to extinction or reduced it relative to the component representing DRA implementation in the context correlated with reinforcement of problem behaviour. Using a similar experimental arrangement, Podlesnik, Bai, and Elliffé (2012) replicated this finding with pigeons.

In the translational study, Mace et al. (2010) presented two children with intellectual disabilities and escape-maintained problem behaviour with a 3-component multiple concurrent baseline that paralleled the rat model. The components were correlated with different staff, who wore different coloured hospital gowns while implementing their

respective procedures in different rooms. Both DRA conditions (C2 and C3) were effective at reducing problem behaviour. In the ensuing extinction phase, responding during extinction was highest by a large margin in C2, as expected. However, combining both therapists from the baseline C1 and C3 conditions eliminated persistence-strengthening effects of DRA (i.e., responding in C1 and the combined C1/C3 components was low and undifferentiated).

A second possible solution to the problem of alternative reinforcement contributing to treatment relapse is directly related to quantitative predictions based on BMT. Nevin, McLean, and Grace (2001) reasoned that extinction (or a lapse in treatment integrity) disrupts responding in three ways: (1) the response-reinforcer contingency is suspended, (2) reinforcers correlated with baseline reinforcement are omitted, thus altering the stimulus conditions associated with baseline responding, and (3) with each extinction session, the effects of the first two disruptors increase. As previously discussed, Shahan and Sweeney (2011) expanded Nevin's quantitative model (Nevin, 1992; Nevin, 2002; Nevin & Grace, 2000) to accommodate the cumulative persistence-strengthening effects of ongoing reinforcement of alternative behaviour (or pro-social replacement behaviour in humans). In Shahan and Sweeney's model, alternative reinforcement both disrupts the target behaviour and strengthens the persistence of the alternative behaviour with each reinforcer delivered in the target stimulus context.

Wacker et al. (2011) tested these predictions with eight children who displayed escape-maintained problem behaviour. A baseline FA was followed by an initial extinction phase. Before problem behaviour extinguished, FCT was implemented over the course of 2 to 3 months. Extended FCT phases and brief extinction phases alternated for several months while the response requirements for escape from demands via communication were increased. As BMT quantitative models predict, the magnitude of resurgence in each subsequent extinction phase generally diminished. Following several months of FCT, the

children were exposed to four common challenges that can lead to treatment relapse: (1) extended duration extinction sessions, (2) novel tasks, (3) removal of communication devices, and (4) resumption of reinforcement of problem behaviour while continuing to reinforce communication. Following the long-term FCT intervention, there were only mild to moderate indications of treatment relapse.

The study described earlier by Pritchard et al. (2014) pointed to a third possible solution to the resistance-strengthening effects of DRA/TCS treatments. Following an FA baseline, in which two therapists reinforced problem behaviour at equal rates, a DRA/TCS treatment was introduced with different rates of reinforcement paired with the two therapists. High- and low-rate DRA/TCS treatment both reduced problem behaviour to comparable levels. However, when equal baseline rates of reinforcement were reinstated, treatment relapse was markedly greater with the therapist who implemented the high-rate reinforcement intervention. Similarly, when the high-rate/low-rate treatments were replicated by the same therapists and extinction followed, treatment relapse was again greatest with the therapist correlated with high-rate DRA/TCS treatment. These results are noteworthy for at least two reasons. First, the finding that low-rate DRA/TCS treatment is comparably effective to the same high-rate treatment is counterintuitive. We speculate that this may have occurred because the treatment favoured the alternative response in ways that are additional to the relative rate of reinforcement. That is, the communication response was very low effort compared to problem behaviour, and the quality of escape may have been preferred because the escape period was free of stimuli correlated with task demands. Second, low-rate DRA/TCS treatments are far more practical to implement than high-rate versions, thereby decreasing the likelihood of lapses in treatment integrity related to not supplying the requisite high-rate reinforcement. These advantages of low-rate DRA/TCS treatments combined with

the finding that they reduce the magnitude of treatment relapse represent a significant advancement in behavioural treatment that was stimulated by basic BMT research.

A final possible treatment modification was demonstrated with pigeons. Sweeney and Shahan (2013) included a reinforcement thinning condition along with rich and lean reinforcement conditions in a resurgence paradigm. They found that thinning reinforcement from rich to thin during a treatment analogue resulted in no treatment relapse compared to the rich reinforcement condition; no relapse was found in the lean reinforcement condition. This recent finding has not been subject to clinical translation research but may hold promise as another alternative to reducing or eliminating treatment relapse.

Summary and Conclusions

Accounts of treatment relapse based on BMT have been supported by basic research showing that the S-S contingency is a reliable predictor of resistance to change and treatment relapse. The translational research studies discussed above suggest that reinstatement, resurgence, and renewal all have external validity as paradigms for treatment relapse. Treatment relapse of problem behaviour and the failure of alternative adaptive behaviour to generalise and maintain has widespread social significance. Although the persistence of problem behaviour is a common phenomenon, interventions based on BMT that may reduce the likelihood of treatment relapse have not yet been evaluated comprehensively in applied settings. Differential reinforcement and interventions based on TCS have been widely reported to reduce problem behaviour and can be successfully used in applied settings, provided that staff can maintain treatment integrity. This review has described how behavioural persistence depends on S-S relations (i.e., the overall rate of reinforcement in any given stimulus context). A number of the applied studies discussed above have demonstrated how the effects of reinforcement rate on both problem behaviour and alternative behaviour can be evaluated. There are significant and ongoing costs associated with the long-term care

of people with intellectual disabilities who present problem behaviour. Their lives are invariably restricted due to the problem behaviour they sometimes present. Interventions that increase the durability of appropriate behaviour, but do not contribute to the persistence of problem behaviour by adding reinforcement to the context associated with the problem behaviour, should receive more attention from translational researchers. It is proposed that interventions using high- and low-rates of reinforcement to evaluate reinstatement, resurgence and renewal of problem behaviour are worthy of further study.

CHAPTER 3³

CLINICAL TRANSLATION OF REINSTATEMENT AND RESURGENCE

The previous chapter reviewed the literature from the perspective of BMT supporting the view that the S-S relationship is a significant factor in the resistance to change of problem behaviour. The development of treatments that are durable across time and contexts is of great interest to clinical practitioners. Of particular interest to translational researchers are the effects of DRA and TCS based treatments on the relapse of problem behaviour following apparently successful treatment. Treatment evaluations based on BMT (i.e., alternating schedules of high- and low-rate treatment) on reinstatement and resurgence relapse paradigms may provide researchers and clinicians with insights into the development of more effective interventions for treating problem behaviour. The following study translated basic research studies into clinical procedures to treat attention-maintained problem behaviour presented by a young man with IDD.

The fundamental finding from BMT research is that behaviour is more persistent during disruption in a context correlated with greater reinforcement (Nevin, 1992; Nevin & Grace, 2000; Nevin, Tota, Torquato & Shull, 1990). This general functional relationship has attracted the attention of translational researchers because of the implications basic BMT research has for common clinical treatments for behaviour disorders such as DRA and variable- and fixed-time reinforcer deliveries (VT, FT).

For example, Ahearn, Clark, Gardenier, Chung and Dube (2003) found that VT access to toys reduced automatically reinforced stereotypic behaviour relative to a no interaction baseline for three children with autistic disorder. However, when stereotypic behaviour was disrupted by providing children continuous access to an activity that competed with

³ This chapter is adapted from 'Clinical translation of animal models of treatment relapse' by Pritchard, D., Hoerger, M., Mace, F. C., Penney, H. and Harris, B. (2014) *Journal of the Experimental Analysis of Behavior*, 101, 442-449, with kind permission of John Wiley and Sons, Inc.

stereotyped responses, stereotypy occurred more often following the VT treatment compared to sessions following the no interaction baseline. BMT predicts this finding due to the higher rate of reinforcement in the VT treatment relative to baseline. Mace et al. (2010) reported similar findings for the effects DRA can have on the resistance to extinction of problem behaviours that were reinforced by socially mediated consequences (attention and food). Thus, although treatments based on alternative reinforcement effectively reduce problem behaviour, they can paradoxically increase its resistance to extinction (cf. Nevin et al., 1990).

Podlesnik and Shahan (2009) examined three paradigms of treatment relapse (reinstatement, resurgence and renewal) with pigeons that are conceptualized within the framework of BMT. A common baseline procedure was used to test each of the relapse models. Pigeons were provided equal VI 120-s response-dependent food in a two-component multiple schedule. Time-contingent food was added to one of the components on a variable time (VT) 20-s schedule. The two relapse paradigms relevant to the current research are *reinstatement* and *resurgence*.

In tests of the reinstatement paradigm, following extinction of baseline responding, food was presented response independently in four sessions and response dependently for another four sessions, with session blocks being separated by a second phase of extinction. Food was presented independently of key pecks at 2 and 8 seconds into the first presentation of each component in a session and later contingent on the first two responses in each component of the session; food was withheld for the remainder of the session. The reinstatement procedure was an analogue of the resumption of reinforcer deliveries that had previously maintained problem behaviour. Although reinforcer rates during the response independent and response dependent tests were identical, the magnitude of relapse was greater in the component with added VT reinforcers during baseline.

For the resurgence model, extinction of the target baseline key in both components was combined with equal VI 30-s DRA for a second key and continued until responding on the target baseline key reduced below 10% of baseline. The resurgence test discontinued reinforcement for all responses, but the response of interest was a resumption of responding on the target baseline key in both components. Despite ongoing extinction of the target and alternative responses, baseline key responding resumed in both components but to a greater extent in the component with the added VT reinforcers in baseline. This procedure models treatment relapse following discontinuation of an effective DRA treatment.

The clinical value of these animal models of treatment relapse depends on the extent to which they predict clinically relevant human behaviour exposed to treatment challenges commonly encountered in clinical settings. Only one clinical translational study has examined the BMT reinstatement paradigm. DeLeon, Willams, Gregory and Hagopian (2005) reported clinical data consistent with the reinstatement model of relapse. Problem behaviour was reinforced by attention on an FR1 schedule during baseline. Following baseline reinforcement, all attention was withheld for problem behaviour until problem behaviour was eliminated for four consecutive sessions. Attention was reintroduced on a FT 60-s schedule for three sessions and problem behaviour immediately returned as predicted by the reinstatement paradigm tested by Podlesnik and Shahan (2009). However, DeLeon et al. (2005) did not arrange different rates of reinforcement in a multiple schedule to demonstrate that reinstatement effects were greater in the component correlated with a higher rate of reinforcement.

We are aware of only one clinical study that approximates a test of one of the BMT paradigms of treatment relapse. MacDonald et al. (2013) conducted a clinical translation of the resurgence paradigm of relapse described by Podlesnik and Shahan (2009) with some variation from the basic research. In the first phase of the study, problem behaviour was

alternately reinforced on a CRF schedule and a variable-ratio (VR) 3 schedule in separate components of a mixed schedule of reinforcement. Each reinforcement component was followed by extinction for all responses. The obtained rates of reinforcement expressed as a ratio of intermittent to continuous reinforcement were 2.30, 1.66, 1.41 and 1.8 for the four participants. Results showed that the transition from the CRF schedule to extinction resulted in substantially higher rates of problem behaviour than the transition from VR 3 to extinction. Although the procedure has no direct parallels with the animal model of resurgence, MacDonald et al. (2013) did demonstrate that relatively higher rates of reinforcement for clinically significant problem behaviour can result in higher response rates during extinction.

The present study aimed to translate the animal models of reinstatement and resurgence into clinical procedures that closely approximate those used in laboratory studies with nonhumans (e.g., Podlesnik & Shahan, 2009, 2010; Sweeney & Shahan, 2013). Both models were tested following a multiple schedule arrangement of a VI VT treatment at different rates, thereby holding constant a 4-to-1 relative reinforcement ratio in the schedule components. Reinstatement was tested by a return to contingent reinforcement of problem behaviour and resurgence was tested by extinction following successful treatment.

Method

Participant, Setting and Materials

The participant was a 16 year-old male with a severe intellectual disability and severe aggressive and disruptive behaviour. He had very limited vocal language and communicated with gestures and one-word mands. He was chosen for this study because previous clinical work had demonstrated that high rates of attention were required to prevent aggression and disruption (Mace et al., 2008). Consent for him to participate in the current research was given by his primary carer. Ethical and governance approval for the research was given by the Bangor University School of Psychology Ethics and Research Committee (2013-10304).

All experimental sessions were conducted in a 10 m by 6 m living area that contained two sofas, two tables with bench seats and an enclosed television. The participant had access to preferred items such as picture books and toys throughout all sessions. One of two therapists and one or two data collectors were present for all sessions. The primary data collector was blind to the experimental hypotheses.

Target Behaviours, Data Collection and Interobserver Agreement

Participant target behaviours were: (a) aggression, defined as slapping, biting, kicking, head-butting, hitting the therapist with an object, spitting on the therapist, forceful pushing, and attempted eye gouging; and (b) disruption, defined as throwing objects and tearing paper. Staff attention took two forms. During the functional analysis baseline and reinstatement phases, staff made disapproving comments (e.g., ‘stop that.’, ‘that hurts.’, ‘don’t tear things up.’) contingent on occurrences of aggression and disruption. During treatment, therapists responded to demands for attention or provided VT attention in the form of pleasant interaction with the participant for approximately 10-s.

Two independent data collectors recorded counts of aggression and disruption in continuous 10-s intervals. Staff attention was recorded using a 10-s partial-interval procedure. Interobserver agreement was balanced across study phases and calculated using the exact agreement method on a point-by-point or interval-by-interval method (Cooper, Heron & Heward, 2007) for an average of 59.3% of the sessions for Phases 1a to 4 and during the entire session for Phase 5. Mean total agreement on occurrences and non-occurrences across all phases was 89.0% (range, 73.6% to 100%).

Procedure

The study was comprised of five successive phases. The conditions in each phase were arranged in a multiple schedule with most components presented in a strictly alternating sequence, with exceptions noted below. Two different therapists served as discriminative

stimuli for the schedule components. Sessions were conducted on consecutive days and all sessions except extinction in Phase 5 were 10 min in duration and separated by a 5 min period without adult attention.

Phase 1—functional analysis baseline. Separate attention and control conditions were conducted by different therapists (three sessions each for the attention condition and three and two control sessions conducted by Therapists 1 and 2, respectively). Both therapists in the attention condition only interacted with the participant contingent on problem behaviour on a quasi-random VI 60-s schedule of reinforcement without a limited hold. In the control condition, the therapist provided near continuous interaction with the participant and provided no instructional demands. Mean obtained rates of attention in the attention condition provided by Therapist 1 were 46.0/hr and 48.0/hr for Therapist 2. No attention was provided contingent on problem behaviour by either therapist in the control condition (see Table 3.1).

Phases 2 and 4—VI VT treatment provided at different rates of reinforcement. Therapist 1 and Therapist 2 provided attention at different rates in a quasi-random VI VT schedule of treatment. Each time reinforcers were scheduled to be available, the therapist approached the participant and pointed to a photograph of the therapist and participant interacting along with a verbal prompt ('would you like to talk?'—serving as an S^D for communication). Communication responses resulted in contingent attention for 10 s (i.e., VI attention). If the participant failed to respond to the prompt, the therapist provided verbal and physical attention for a similar duration (i.e., VT attention). Therapist 1 provided attention on a VI VT 30-s schedule and Therapist 2 provided the same treatment on a VI VT 120-s schedule. No interaction occurred during the inter-reinforcement intervals. Obtained rates of attention averaged 120/hr for Therapist 1 and 30/hr for Therapist 2 in both treatment phases. The VT component of the treatment permitted scheduled and obtained reinforcement rates to

be equivalent. Treatment sessions continued in phase 2 and phase 4 until average rates of problem behaviour for both therapists were 8.5% and 17% of the initial functional analysis baseline, respectively.

Phase 3—Reinstatement of equal rates of reinforcement. Following the initial treatment phase, the VI VT intervention was discontinued and both therapists resumed reinforcement of aggression and disruption on equal VI 60-s schedules of reinforcement. In the attention condition, the mean rates of attention provided by Therapist 1 were 46.8/hr and 48.0/hr, respectively. In the control condition, no attention was provided contingent on problem behaviour by either therapist (see Table 3.1).

Phase 5—Extinction test of resurgence. A single 74-minute session of extinction followed the second treatment phase for each therapist. The therapist stood within 1 m of the participant at all times and did not look at or talk to the participant during the entire session. Therapist 1 conducted the first extinction session and Therapist 2 conducted the second session four hours later.

Results

Figure 3.1 shows the participant's rates of aggression and disruption during the functional analysis baseline, VI VT treatments in the initial and replication phases, and reinstatement of baseline reinforcement of problem behaviour as implemented by the two therapists. Mean responses per minute by phase and therapist are presented in Table 3.1. The functional analysis baseline showed clear differentiation between problem behaviour in the attention condition (Phase 1a) and the control condition (Phase 1b) for both therapists, thus confirming that problem behaviour was maintained by therapist attention. The VI VT intervention produced similar reductions in problem behaviour across therapists in both treatment phases ($M = 2.7/\text{min}$ for Therapist 1 and $1.9/\text{min}$ for Therapist 2—reduced from $8.3/\text{min}$ in the functional analysis baseline) despite the fourfold difference in treatment

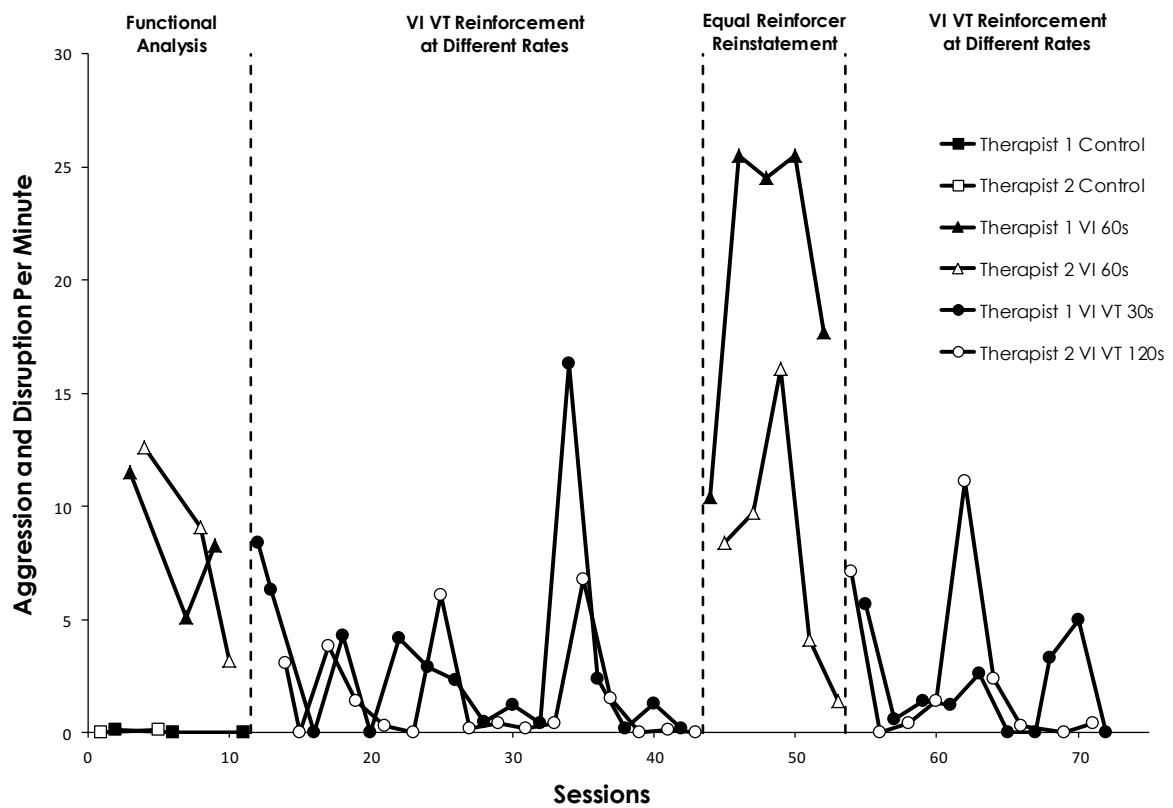


Figure 3.1. Aggression and disruption per min for all sessions in the functional analysis and reinstatement phases and two VI VT treatment phases conducted by Therapist 1 and Therapist 2.

Table 3.1

Mean response rates and obtained reinforcer rates contingent on problem behaviour in all phases except Phase 1a for Therapist 1 and Therapist 2.

	Phase 1a		Phase 1b		Phase 2		Phase 3		Phase 4		Phase 5	
	Equal BL SR+		BL Control		Unequal VI VT SR+		Equal SR+ Reinstatement		Unequal VI VT SR+		EXT Resurgence	
	Responses /min	SR+/hr	Responses /min	SR+/hr	Responses /min	SR+/hr	Responses /min	SR+/hr	Responses /min	SR+/hr	Responses /min	SR+/hr
Therapist 1	8.30	46	0.03	0	3.18	120	20.72	46.8	1.98	120	1.95	0
Therapist 2	8.30	48	0.05	0	1.52	30	7.94	48	2.63	30	0.89	0

reinforcement rates that favoured Therapist 1. However, reinstatement of comparable rates of baseline reinforcement resulted in the return of problem behaviour that averaged 2.6 times higher with Therapist 1 who implemented the higher rate VI VT treatment. Mean

reinstatement data expressed as proportion of baseline was 2.5 for Therapist 1 and 0.95 for Therapist 2.

Figure 3.2 shows the cumulative number of aggressions and disruptions during the single extended extinction session for both therapists and represents a test of the resurgence paradigm of relapse. Problem behaviour first occurred 14.8 min into extinction for Therapist 1 and there were four occurrences at minute 19.2. High-rate problem behaviour began at minute 36.5; however, there were only eight occurrences of problem behaviour prior to this point. Responding remained fairly steady until minute 54.7, lasting 18.2 min, and then slowed markedly to minute 74.0 when there had been 5.0 min without problem behaviour. For Therapist 2, the first problem behaviour occurred comparatively early into extinction at minute 2.0 and two more responses occurred at minute 3.2.

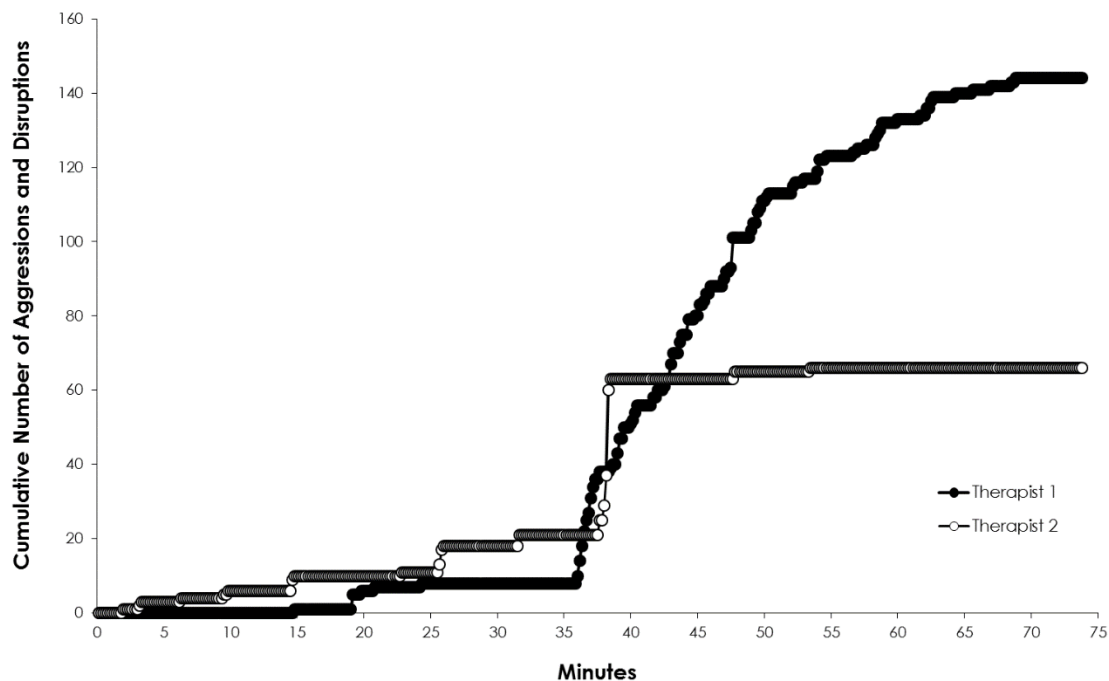


Figure 3.2 Cumulative number of aggressions and disruptions per min during a single extinction session for Therapist 1 and Therapist 2.

A sharp but short burst of responding (63 responses in 0.8 min) began at minute 37.7 after 25 responses had occurred. At minute 38.5, responding stopped abruptly with only 3 responses

occurring the remainder of the resurgence test. Overall response rate during extinction was 1.9/min for Therapist 1 compared to 0.9/min for Therapist 2.

Discussion

This study is the first clinical translation of the reinstatement paradigm of treatment relapse based on BMT research that conducted relapse tests following treatments with different rates of reinforcement. Following a multiple schedule baseline reinforcement of problem behaviour at equal rates by two therapists, treatment was introduced using a VI VT schedule arrangement with therapists delivering reinforcers at different rates at a 4-to-1 ratio. Despite the differing rates of VI VT reinforcers, the treatment produced comparable reductions in problem behaviour. Following successful treatment, the two therapists discontinued treatment and resumed reinforcement of problem behaviour at equal rates that constituted a reinstatement of baseline conditions (see Podlesnik & Shahan, 2009; response-dependent reinstatement). As predicted by BMT, reinstatement resulted in an immediate return of high rates of problem behaviour that were 2.6 times higher for the therapist using the higher rate VI VT treatment. A second treatment phase was implemented followed by a test of resurgence in a single extended extinction session conducted separately for each therapist. The unequal VI VT treatment rates implemented by therapists resulted in 2.1 times greater responding in the resurgence test for the therapist who implemented the higher rate VI VT procedure (cf., MacDonald et al., 2013).

This study should be considered preliminary because the demonstrations were made with only one participant. Had multiple participants been studied, the order of the resurgence extinction tests across therapists could have been counterbalanced. This leaves open the possibility that the lower frequency of responding during extinction for Therapist 2 may have been partially affected by Therapist 1 conducting extinction four hours earlier. However, the participant's first response during extinction with Therapist 2 occurred approximately 12.8

min before it did with Therapist 1, and the response rate being 2.1 times higher for Therapist 1 than Therapist 2 is similar to the first extinction session in Podlesnik and Shahan (2009, Figure 4, p. 361).

A key feature of BMT relapse experiments is that they employ a 2-component multiple schedule with different reinforcer rates in the components. This phase provides the basis for between-component comparisons during extinction and the subsequent reintroduction of reinforcers. This clinical translation differed from the procedures used by Podlesnik and Shahan (2009). In the animal model, the 2-component baseline that served as the basis for comparisons during relapse tests was analogous to baseline reinforcement of problem behaviour. By contrast, these relapse tests followed a 2-component treatment designed to produce clinically significant reductions in problem behaviour from a no-treatment baseline.

A second difference between the animal and translational procedures was the amount of reinforcement provided during reinstatement. In the animal model of reinstatement, the response-independent and response-dependent variations both provided only two reinforcers in the first presentation of each component in a session. Pyszczynski and Shahan (2011) used a similar response-independent procedure in a relapse model of ethanol seeking. From a clinical translation viewpoint, these animal models can be seen as temporary reinstatement of reinforcers and represent a short-term lapse in treatment integrity (i.e., failing to withhold reinforcement of problem behaviour). The present clinical translation returned to VI 60-s reinforcement throughout all reinstatement sessions, clinically representing a complete lapse of treatment integrity.

A third difference between the laboratory and clinical procedures is the number and duration of the extinction sessions. In their resurgence experiment, Podlesnik and Shahan (2009) discontinued reinforcement of the target and alternative keys in both components for

two consecutive 5-session blocks. The clinical test of resurgence was done in a single extended extinction session for both therapists. Conducting several extinction sessions with a participant with clinically severe behaviour disorder can be contraindicated if the behaviour is capable of producing serious injury. Therefore, we opted for a single session of extinction for both therapists to minimize as much as possible any injury to the therapists. However, despite the procedural differences between the laboratory models and clinical translations, the clinical findings reported here are consistent with the nonhuman data and are predicted by BMT.

Although the present study is preliminary, if the clinical findings are replicated, it suggests that DRA and/or VT/FT treatments may have the undesirable side effect of strengthening the persistence of problem behaviour and increasing the likelihood of treatment relapse when treatment integrity is compromised. This study is also consistent with recent basic research with rats. Sweeney and Shahan (2013) compared the effectiveness and resistance to extinction of high-rate and low-rate DRA that differed by tenfold. Both the target response (lever press) and alternative response (nose poke) were more resistant to extinction in the high-rate DRA component. The finding that the magnitude of relapse may be greater using higher rate reinforcers contradicts practice that is widely prescribed in the applied behaviour analysis literature (Carr et al., 2000; Chowdhury & Benson, 2011; Cooper, Heron & Heward, 2007; Petscher, Rey & Bailey, 2009).

Basic and clinical researchers have begun examining solutions to this undesirable side effect of DRA and/or VT/FT behavioural treatments. Mace et al. (2010) showed first with rats and then with children with intellectual developmental disabilities that increased resistance to extinction could be reduced or eliminated by first training the alternative response in a separate context from the context correlated with reinforcement of a target response or problem behaviour. Once the alternative response is established, discriminative

stimuli for the alternative response can be introduced to the treatment setting and effectively treat problem behaviour without increasing the magnitude of relapse. Podlesnik, Bai & Elliffe (2012) replicated this general finding with pigeons. Wacker et al. (2011) suggested a second relapse remedy. They provided extended functional communication training (FCT) to treat children's destructive behaviour over an average of nine months. FCT is a differential reinforcement of alternative behaviour (DRA) procedure during which an individual is taught a communicative behaviour that replaces the problem behaviour. Typically, the problem behaviour is placed on extinction (Carr & Durand, 1985). At four points in time during the course of the children's treatment, discontinuation of DRA combined with extinction provided tests of resurgence. The average magnitude of relapse reduced over successive resurgence tests. The data patterns over the long-term treatment conformed closely to a formula developed by Shahan and Sweeney (2011) that assumes that DRA simultaneously disrupts problem behaviour and strengthens the persistence of alternative behaviour.

The present study suggests a third potential solution to the problem of treatment relapse. VI VT treatment produced comparable reductions in problem behaviour when delivered at both high and low rates. Basic researchers may find this finding counterintuitive. For example, in the Sweeney and Shahan (2013) study, high-rate DRA produced more rapid reductions in the target response and rapid acquisition and rate of the alternative response compared to the low-rate DRA condition. However, these opposite clinical findings may be attributable to the composition of contemporary behavioural treatments. It is common for behavioural treatments to make the alternative response less effortful and to reinforce the alternative response with a reinforcer of higher quality than the reinforcer maintaining problem behaviour (Mace & Roberts, 1993). The present VI VT treatment required the participant to point to a photograph to receive attention in the form of smiles, praise, back pats and tickles compared to disapproving comments provided in the functional analysis

baseline. If replicated, this finding that low-rate treatment was as effective as high-rate treatment will have beneficial implications for clinicians who aim to achieve good treatment integrity in natural settings for long periods of time. Low-rate reinforcement-based treatments have been found to yield better treatment integrity than their high-rate counterparts (Chowdhury & Benson, 2011).

Finally, Sweeney and Shahan (2013) demonstrated a fourth potential remedy for treatment relapse. In addition to a high-rate and low-rate DRA condition, their experiment included a schedule thinning condition. The high-rate and thinning conditions began the first session with VI 10-s reinforcement of nose poking. The fading group of rats had their schedules thinned daily by 10 s until it reached the value of the low-rate DRA group (i.e., VI 100-s). During the resurgence extinction test, relapse was significantly lower in the thinning group compared to the high-rate DRA group, and was not statistically different from the low-rate DRA group. This is important because it modelled a practical and widely used schedule thinning procedure that significantly reduced the magnitude of treatment relapse relative to the high-rate DRA condition.

The present study and those cited in this chapter illustrate a theory-driven approach to conceptualize clinical phenomena and establish the basic processes involved in the serious clinical problem of treatment relapse. In many cases, basic and clinical researchers are collaborating formally and informally on their work following a bi-directional translation research model (Mace, 1994; Mace & Critchfield, 2010). The pace of development of the BMT model of treatment relapse appears to be benefiting from this approach to research.

CHAPTER 4⁴

CLINICAL TRANSLATION OF ABA RENEWAL

The previous chapter described the results of two studies that demonstrated the effects of high and low rate treatment for problem behaviour based on BMT. The first study evaluated the effects of the reintroduction of reinforcement for problem behaviour which led to the reinstatement of problem behaviour. It was noteworthy that, as predicted by BMT, that relapse was greater in the component with high-rate treatment. The second study demonstrated that problem behaviour was more resistant to extinction following high-rate treatment compared to low-rate treatment. Again, this finding is predicted by BMT. Both studies took place in the same stimulus context (i.e., the participant's living accommodation). Of particular interest to clinical practitioners, however, is the ABA renewal of problem behaviour. ABA renewal occurs when a behaviour that is occurring in one context (Context A) is then extinguished in a separate context (Context B) only for it re-occur when the participant returns to Context A despite the extinction condition being in operation. The ABA renewal model is of interest to translational researchers because it is analogous to a drug user being apparently successfully treated for addiction as an in-patient in a clinic only to relapse following discharge on their return to the environment associated with drug abuse (Brownell, Marlatt, Lichenstein & Wilson, 1986). In the residential school where the reinstatement and resurgence studies described in Chapter 3 were carried out, ABA renewal is sometimes observed when a student's behaviour has been successfully treated in the school only for it to relapse when the student returns home during the weekends or school holidays.

In the renewal relapse model, the context is considered to include any stimulus in the environment that might affect performance in the extinction condition (Bouton &

⁴ This chapter is adapted from 'Clinical translation of the ABA renewal model of treatment relapse' by Pritchard, D., Hoerger, M., Mace, F. C., Penney, H., Harris, B. and Eiri. Ll. (under review)

Swartzentruber, 1991; Welker & McAuley, 1978). Renewal is a concern because the effects are persistent over time, even surviving multiple extinction sessions (Denniston, Chang & Miller, 2003). Denniston et al. reported that ABA renewal is more persistent than ABC renewal (i.e., three different contexts) or AAB renewal (i.e., when extinction is used in Context A prior to extinction in Context B).

It is surprising that ABA renewal has received so little attention from translational or applied researchers. Recently, Kelley et al. (2015) carried out two experiments. The first, with pigeons, was translated into an experiment with children with autism as the participants. The experimenters demonstrated ABA renewal in both experiments when the pigeons and the children were returned to their original stimulus context (i.e., Context A). In an earlier example, Lalli, Casey and Kates (1997) reported that two out of three participants treated in a clinic for problem behaviour demonstrated renewal (although it was not described as such) when they returned to their respective schools and homes despite treatment integrity being maintained. In contrast, there are numerous examples of ABA renewal in the basic operant research literature. For example, the paradigm has been used to demonstrate that rats resume drug-seeking behaviour in contexts previously associated with drug self-administration (e.g., Crombag & Shaham, 2002; Zironi, Burattini, Aicardia & Janak, 2006). Nakajima, Tanaka, Urushihara & Imada (2000) used rat subjects to show that ABA renewal could be readily demonstrated but not AAB renewal, suggesting that extinction in another context or a return to the original context are key factors for the renewal of extinguished behaviour. Nakajima, Urushihara & Masaki (2002) later replicated Nakajima et al.'s ABA renewal experiment with similar results. Bouton, Todd, Vurbic and Winterbauer (2011) examined the role of context in operant extinction in rats. In four experiments lever pressing was reinforced on VI 30-s schedule in ABA, ABC and AAB renewal. Renewal was demonstrated in all three paradigms, but was strongest in the ABA experiment (see also Crombag & Shaham, 2002). Todd,

Winterbauer and Bouton (2012) replicated Bouton et al. and again demonstrated that renewal was strongest in the ABA experiment. Berry, Sweeney & Odum (2014) reported similar findings in pigeons that were first tested with an ABA renewal preparation prior to an ABC renewal preparation, although Berry et al. speculate that greater relapse in the ABA experiment may be due to the order in which the experiments were conducted because repeated extinction tests tend to weaken behaviour.

Treatments based on applied behaviour analysis such as differential reinforcement of alternative behaviour (DRA) and TCS have recently been evaluated by translational researchers using BMT and it has been demonstrated that the high rates of reinforcement sometimes used during treatment may be contributing to the relapse of problem behaviour during lapses in treatment integrity (e.g., Mace et al., 2010; Pritchard et al., 2014; Wacker; 2011). However, the renewal model is worthy of further investigation because it suggests that problem behaviour will relapse even if treatment integrity is maintained (e.g., Lalli et al., 1997). The present study translated the basic ABA renewal model using a procedure that closely approximated Podlesnik & Shahan (2009; Experiment 3) but, rather than training an arbitrary behaviour in Context A, attention maintained problem behaviour was treated with a multiple schedule arrangement of VI VT reinforcement at different rates in Context A, two extinction sessions in Context B, and then two renewal tests in Context A.

In Podlesnik & Shahan's (2009; Experiment 3) renewal experiment pigeons were first provided with equal VI 120-s response-dependent food in a two-component multiple schedule. A steady houselight (i.e., Context A) remained on during all eighty baseline sessions. Time-contingent food was then added to one of the components on a variable time (VT) 20-s schedule. Extinction tests followed the baseline multiple schedule during which the houselight flickered on and off at a rate of 0.1 per second (i.e., Context B), and food reinforcement was stopped in both the VI 120-s (i.e., lean) and VI 120-s VT 20-s (i.e., rich)

components. After responding had fallen below 10% of baseline, the renewal test reintroduced the steady houselight (i.e., a return to Context A) and extinction remained in effect. The results demonstrated that responding was more persistent during extinction in the rich component compared to the lean component.

Method

Participant, Setting and Materials

The participant was an 18 year-old male with severe intellectual disability accommodated at a residential school for treatment of his severe aggressive and disruptive behaviour. His communication was limited to single words (e.g., greetings, mands for attention, caregivers names, favourite foodstuffs, preferred toys and activities) and gestures. Previous clinical work had demonstrated that the participant required high levels of staff attention to prevent episodes of aggression and disruption from occurring. Consent for him to participate in the current research was given by his primary carer. Ethical and governance approval for the research was given by the Bangor University School of Psychology Ethics and Research Committee (2013-10304).

The experimental sessions were conducted in two 8 m by 6 m classrooms, one painted orange (Context A) and the other painted blue (Context B). These colours were chosen because they were considered easy for the participant to discriminate between to signify the two different contexts. One of two therapists and two data collectors were present for all sessions.

Target Behaviours, Data Collection and Interobserver Agreement

The participant's target behaviours were: (a) aggression, defined as slapping, biting, kicking, head-butting, hitting the therapist with an object, spitting at the therapist, forceful pushing, and attempted eye gouging; and (b) disruption, defined as throwing objects and tearing paper. During the procedure, the therapists responded to mands for attention or

provided VT attention in the form of pleasant interaction with the participant for approximately 10-s.

Two independent data collectors recorded counts of aggression and disruption in continuous 10-s intervals. Staff attention was recorded using a 10-s partial-interval procedure. Interobserver agreement was calculated using the exact agreement method on a point-by-point or interval-by-interval method for all sessions for Phases 1 to 3. Mean total agreement on occurrences and non-occurrences across all phases was 92% (range, 85% to 100%).

Procedure

Previous clinical work with this participant indicated that his problem behaviour was reinforced by attention (Mace et al., 2008; Pritchard et al., 2014) so no functional analysis was administered. The study comprised three successive phases. The conditions in the first phase (i.e., VI VT treatment in Context A) were arranged in a multiple schedule with the components presented in an alternating sequence. The second phase comprised separate extinction sessions carried out consecutively by each therapist in Context B the following day. The third phase (i.e., the renewal tests) comprised separate extinction sessions carried out by each therapist in Context A on consecutive days.

Phase 1—VI VT treatment provided at different rates of reinforcement in Context A. Therapist 1 and Therapist 2 provided attention at different rates in a quasi-random VI VT schedule of treatment. Each time reinforcers were scheduled to be available, the therapist approached the participant and engaged him in a brief conversation. Communication responses resulted in contingent attention for 10-s (i.e., VI attention). If the participant failed to respond to the verbal prompt, the therapist provided verbal and physical attention for a similar duration (i.e., VT attention). Therapist 1 provided attention on a VI VT 30-s schedule and Therapist 2 provided the same treatment on a VI VT 120-s schedule. No interaction occurred during the inter-reinforcement intervals. Obtained rates of attention averaged 120/hr

for Therapist 1 and 30/hr for Therapist 2 in both treatment phases. The VT component of the treatment permitted scheduled and obtained reinforcement rates to be equivalent. Treatment sessions continued in each phase until rates of problem behaviour were stable.

Phase 2—extinction in Context B. Following the VI VT treatment phase the participant was transferred to Context B and Therapist 1 and 2 carried out separate extinction tests. During each extinction session, each therapist stood within 1 m of the participant at all times and did not look at or talk to the participant during the session.

Phase 3—extinction test of renewal in Context A. The participant was transferred back to Context A and each therapist carried out a separate extinction test. During each test the therapist stood within 1 m of the participant at all times and did not look at or talk to the participant.

Results

Figure 4.1 shows the participant's rates of aggression and disruption during the VI VT treatment phase. The last six VI VT treatment sessions produced comparable rates of problem behaviour across both therapists (i.e., $M = 4.7/\text{min}$ for Therapist 1 and $4.5/\text{min}$ for Therapist 2) despite the fourfold difference in treatment reinforcement rates that favoured Therapist 1 (i.e., the rich schedule). Figure 4.2 shows the cumulative number of aggressions and disruptions during both extinction sessions in Context B. There were no occurrences of the target behaviours for Therapist 1 and only relatively low levels of responding for Therapist 2. Responding stopped after 3 min with Therapist 2, restarting after 5 min for 20 sec and occurred only sporadically thereafter until minute 37 (cf. Pritchard et al., 2014).

Figure 4.3 shows the cumulative number of aggressions and disruptions during the renewal tests in Context A for both Therapist 1 and Therapist 2. Both extinction sessions were terminated after 5 min without problem behaviour. During the renewal test with Therapist 1 the participant presented problem behaviour for 107.17 min (see Table 4.1).

During the renewal test for Therapist 2 the participant presented problem behaviour for 24.17 min (i.e., a 78% reduction in time to extinction compared to Therapist 1). Problem behaviour occurred at a steady rate throughout both extinction sessions, but at a slightly higher rate with Therapist 2 (20.7/min) compared to Therapist 1 (20.15/min) for the first 24.17 min. The overall rate of problem behaviour with Therapist 1 during the renewal test was 11.87/min.

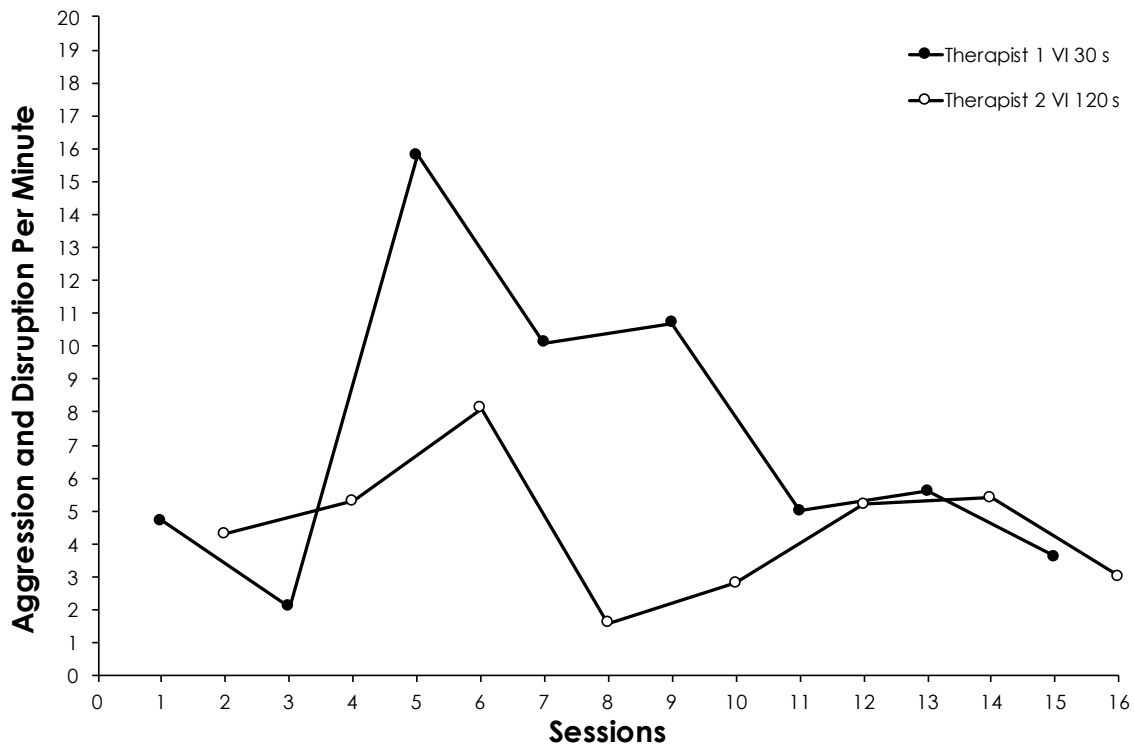


Figure 4.1. Aggression and disruption per min for all sessions in the VI VT treatment phase conducted by Therapist 1 and Therapist 2 in Context A

Table 4.1.

Mean response rates and obtained reinforcer rates contingent on problem behaviour in all phases for Therapist 1 and Therapist 2.

	Phase 1 Context A Treatment		Phase 2 Context B		Phase 3 Context A		Time to EXT (min)
	Responses /min	SR+/hr	Responses /min	SR+/hr	Responses /min	SR+/hr	
Therapist 1	7.2	120	0	0	11.87	0	107.17
Therapist 2	4.5	30	1.9	0	20.7	0	24.17

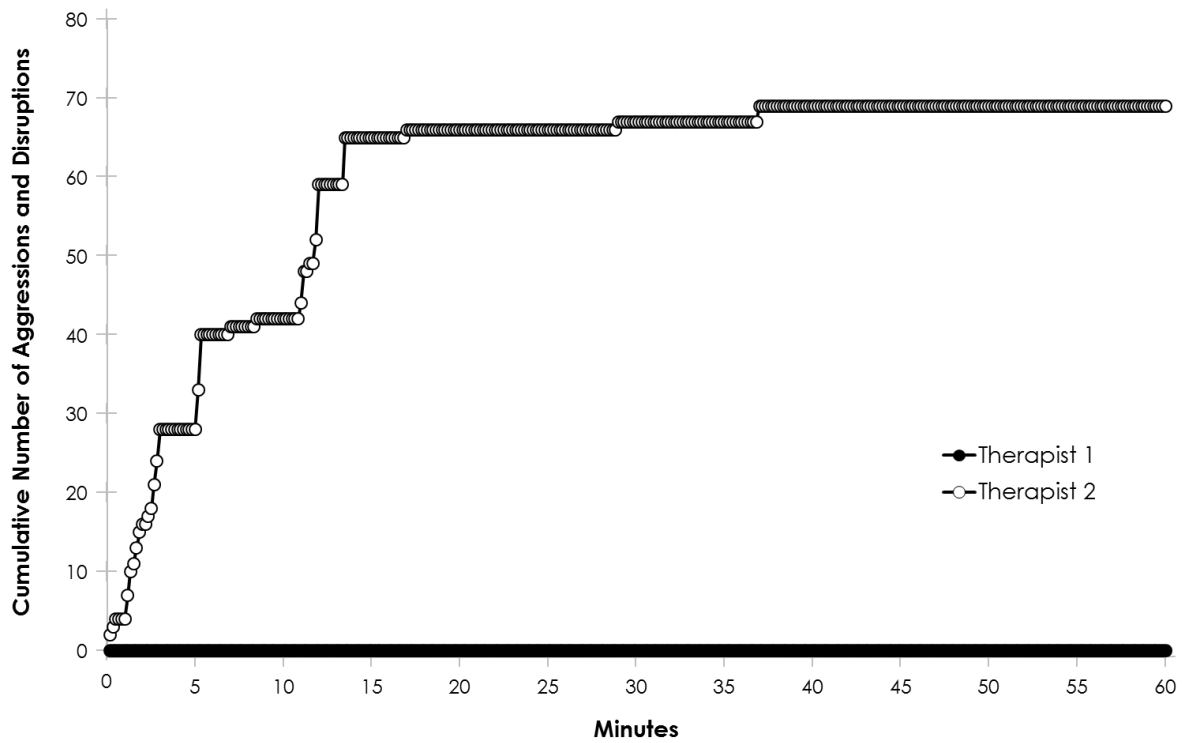


Figure 4.2. Cumulative number of aggressions and disruptions recorded in consecutive single extinction sessions in Context B for Therapist 1 and Therapist 2.

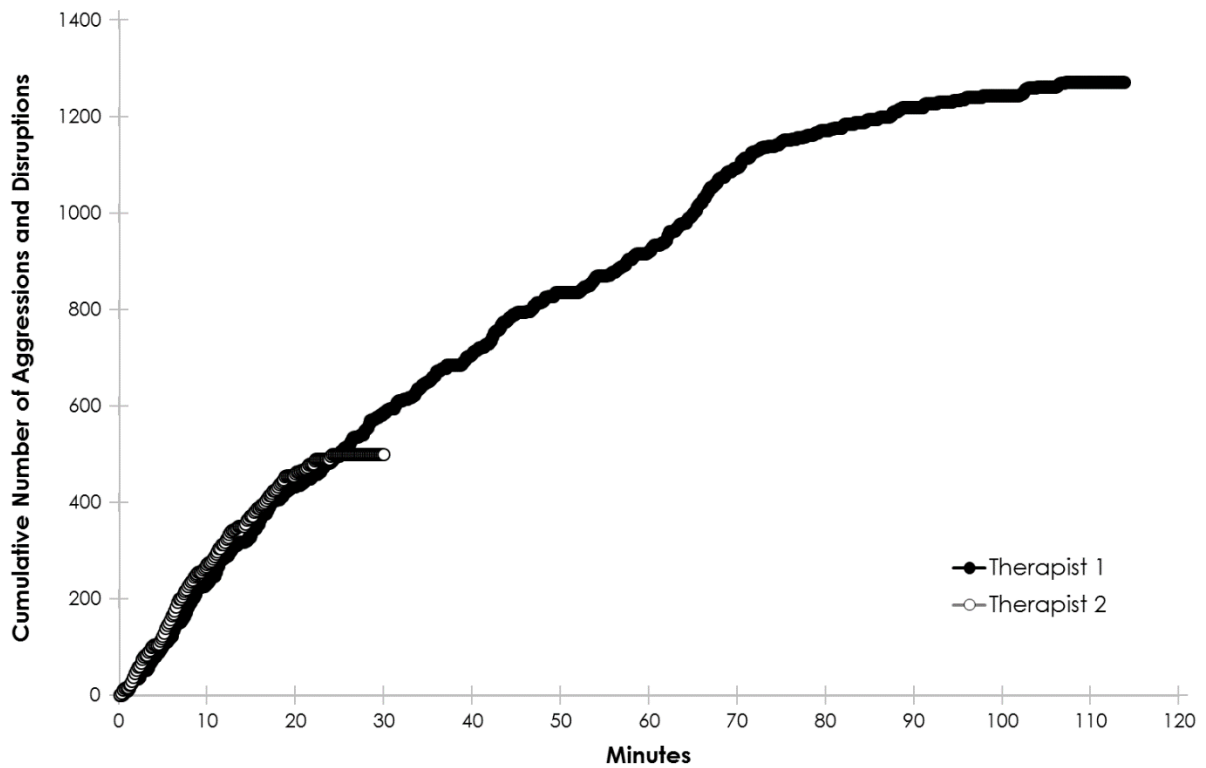


Figure 4.3. Cumulative number of aggressions and disruptions recorded in a single extinction session in Context A for Therapist 1 and Therapist 2.

Discussion

This translational study replicated Podlesnik and Shahan (2009; Experiment 3) and evaluated the effect of a treatment procedure based on BMT on ABA renewal. ABA renewal is analogous to a client receiving apparently successful treatment in a clinic, only for the problem behaviour to relapse when the client returns to their school or home. The procedure described here used a VI VT schedule arrangement with therapists delivering reinforcers at different rates in a 4-to-1 ratio. Despite the differing rates of VI VT reinforcers, the procedure stabilized problem behaviour to similar rates. This is an important finding for practitioners (see also Pritchard et al., 2014) as it suggests that behaviour can be successfully treated with lower rates than would ordinarily be expected (Carr et al., 2000; Chowdhury & Benson, 2011; Cooper, Heron & Heward, 2007; Petscher, Rey & Bailey, 2009).

Following the VI VT procedure in Context A, the two therapists placed all behaviours on extinction in Context B. This condition is analogous to the Context B extinction condition in Podlesnik & Shahan (2009; Experiment 3) where the steady houselight of Context A was replaced with a flickering houselight. Clinical translations of basic research cannot always systematically replicate the original experiments which generally take place in conditioning chambers and are usually controlled by computers. For example, it was not practical to install a system that would make the room lights flicker (e.g., Podlesnik & Shahan, 2009) or to use odours to create the different contexts (e.g., Todd, Winterbauer & Bouton, 2012). Instead, the contexts were made different by painting the walls of identical classrooms in distinctively different colours and the windows were painted over with white emulsion to avoid distractions from outside.

In typical basic research experiments that have evaluated ABA renewal the organism is trained to respond to a stimulus in Context A, the response is extinguished in Context B and after responding has been extinguished the organism is returned to Context A where

extinction remains in operation (e.g., Podlesnik & Shahan, 2009). In most basic research experiments, the organism usually remains in the same conditioning chamber and the environmental stimuli are changed. In the current study, VI VT treatment was successfully used to stabilize problem behaviour in Context A. As can be seen from Figure 2, in Context B the participant's did not respond in the presence of Therapist 1 and responding occurred at only a low rate with Therapist 2. This appears paradoxical, but Bouton (2000) suggests a possible explanation for the participant's behaviour. Bouton noted that the context switch from A to B often resulted in no behaviour decrement and that 'conditioning generalizes remarkably well across contexts' (Bouton, 2000, p. 58). In this study, each therapist escorted the participant to the blue classroom (Context B) from a small lobby area where he had been waiting supervised by his regular staff who had achieved stimulus control over his problem behaviour over a period of years. This may have contributed to generalization between the participant and his regular care staff and the subsequent maintenance of appropriate behaviour throughout the extinction session with Therapist 1 and only low rate responding with Therapist 2 (Bouton, 2002).

When the participant was returned to Context A (i.e., the orange classroom) for the renewal tests, problem behaviour was presented for 107.17 min during the test carried out by Therapist 1 but for only 24.17 min for Therapist 2 (i.e., problem behaviour was over four times more persistent following high-rate reinforcement compared to low-rate reinforcement). This result is consistent with BMT and demonstrates the strong effect of ABA renewal. Rates of problem behaviour were comparable (i.e., 20.7/min for Therapist 1 and 20.15/min for Therapist 2) for the first 24.17 minutes of each session.

By employing a 2-component multiple schedule with different reinforcer rates in each component, BMT provides a relatively convenient way of evaluating treatment relapse models. This clinical translation differed from the procedures used by Podlesnik and Shahan

(2009) in that the 2-component treatment phase served as the basis for comparisons during the relapse tests. A second difference between the laboratory and clinical procedure here is the number and duration of the extinction sessions. Podlesnik and Shahan (2009) discontinued reinforcement of the target and alternative keys in both components for two consecutive 5-session blocks, but the current study used single extended extinction sessions for both therapists. However, despite the procedural differences between the basic research and the clinical translation reported here, the findings are consistent with, and predicted by, BMT.

The findings of the present study support those of Pritchard et al. (2014) who reported that high rate DRA and/or time-based treatments may have the undesirable side effect of strengthening the persistence of problem behaviour and increasing the likelihood of treatment relapse when treatment integrity is compromised. The finding that the magnitude of relapse may be greater using higher rate reinforcers contradicts accepted practice in applied behaviour analysis. The current study suggests a potential solution to the problem of treatment relapse. VI VT treatment produced comparable rates of problem behaviour when delivered at both high and low rates. If replicated, the finding that low-rate treatment was as effective as high-rate treatment should be noted by clinicians who aim to achieve good treatment integrity in natural settings for long periods of time because low-rate reinforcement-based treatments have been found to yield better treatment integrity than their high-rate counterparts (Chowdhury & Benson, 2011).

Basic researchers have identified that renewal can be attenuated by carrying out extensive extinction trials in multiple contexts. If this finding has applicability to operant behaviour in people with intellectual disabilities, it suggests that treatment relapse following renewal may only be avoided if the problem behaviour is extinguished in multiple treatment contexts. Another solution proposed by basic researchers (e.g., Berry et al., 2014) is that

following treatment in Context B, the client is moved to a novel context (i.e., Context C, one that makes it less likely that relapse will occur, or if it does occur, its magnitude will be reduced). These possible solutions may be difficult to achieve in applied settings on both practical and safety grounds, making it important that interventions to reduce problem behaviour do not inadvertently contribute to its persistence.

This study appears to be the first clinical translation of the BMT model of ABA renewal. However, its findings should be considered preliminary because only one participant contributed to the study and the order in which the extinction sessions were conducted were not counterbalanced. Future studies should control for order effects because the extent to which having Therapist 1 conduct the extinction sessions first in both Context B and Context A affected the findings is unknown. Nevertheless, clinical replications of ABA renewal are clearly warranted. Future studies could also examine the effects of low- and high-rate reinforcement in AAB and ABC renewal models, in addition to utilizing other motivating operations such as access to preferred activities and escape from demands.

CHAPTER 5⁵

TRAINING STAFF TO AVOID PROBLEM BEHAVIOUR

The previous chapters have reviewed BMT and reported the findings of three experiments demonstrating the benefits of using low-rate reinforcement schedules to reduce both the rate of problem behaviour and the magnitude of treatment relapse when treatment integrity is compromised. Both the resurgence and renewal preparations demonstrated that problem behaviour was more resistant to extinction following high-rate treatment compared to low-rate reinforcement. The reinstatement preparation also demonstrated that the magnitude of the relapse of problem behaviour was greater following high-rate treatment compared to low-rate treatment. Although preliminary, these findings suggest that the apparent benefits of low-rate treatment should be carefully considered by behaviour analysts when designing and implementing treatment programmes.

An added benefit of low-rate treatment is that it is more likely to be implemented with integrity (Chowdhury & Benson, 2011). Treatment integrity is the degree to which staff implement a behaviour support plan (BSP) as prescribed. High treatment integrity typically strengthens the effects of an intervention (Fiske, 2008). One reason for treatment relapse due to poor treatment integrity is that staff have not been effectively taught to interact with clients in the moments surrounding behavioural incidents. Behaviour analysts will sometimes directly train the staff to implement the intervention, but more often staff will be expected to read and learn a BSP before putting it into practice (Ravoux, Baker & Brown, 2012). However, the literature on staff training suggests that staff do not always follow BSP's as they have been prescribed. Hastings (1996) reported staff responses to a questionnaire asking them how they would respond to various forms of problem behaviour displayed by adults

⁵ This chapter is adapted from 'Training staff to avoid problem behavior related to restricting access to preferred activities' by Pritchard, D., Hoerger, M., Penney, H., Eiri, Hellawell, L., Fothergill, S. and Mace, F. C. (2015), *Behavior Analysis in Practice*. doi: 10.1007/s40617-015-0061-4, with kind permission from Springer Science and Business Media.

with intellectual disabilities. Staff responses suggested that they would not correctly follow behaviour management plans when dealing with actual episodes of problem behaviour. Hastings speculated that this was because they were not well enough informed or that they may find that other short-term strategies, such as response suppression, are easier to implement. Hastings recommended that the training of direct-care staff requires greater emphasis on practical skills to enable staff to manage problem behaviour as it actually occurs.

This chapter describes the development of a staff training programme that was designed to ensure staff maintained the treatment integrity of an intervention to prevent problem behaviour escalating when students living at a residential special school had to be denied access to a preferred activity (Pritchard et al., 2015). The training programme was based on a BSP developed by Mace et al., (2011) in response to severe problem behaviour presented by a 13 year-old boy when he had to be denied access to a computer because it was not available or because he should have been engaged in an academic or other set task. The intervention was shown to be effective in reducing rates of problem behaviour compared to baseline. Pritchard et al. (2011) successfully replicated the intervention with another male student who attended the same residential school.

Despite the evidence from these successful studies, and subsequent amending of the BSP's for the nine other students whose functional behavioural assessments demonstrated that their problem behaviour had a tangible function, an analysis of critical incident reports showed that around 35% of incidents per year still occurred when students had to be denied access to a preferred activity. Severe behaviours occurred at a low rate, but often resulted in staff injury which put the student at risk of exclusion and/or facing charges for assault from the police.

Up until the development of the programme, staff training was comprised of reading and learning each individual student's BSP followed by 'on the job' training (Sterling-Turner

et al., 2001). ‘On the job’ training involved the trainee staff observing how more experienced staff managed problem behaviour. Following trainee staff involvement in an incident they would receive verbal feedback from their line manager. By contrast, Courtemanche et al. (2014) evaluated a comprehensive program to teach behaviour management skills during actual staff-client interactions. The program was comprised of role-playing, in-vivo training, performance feedback, monetary reinforcement, and avoidance of training sessions contingent on accurate implementation of behaviour management plans. However, Courtemanche et al. (2014) were able to schedule in-vivo training at convenient times because staff were being trained to implement behaviour management plans for clients who engaged in high rates of self-injurious behaviour. Harchik and Campbell (1998) also recommended that role-play and in-vivo modelling of behaviour management strategies are more likely to develop actual behaviour management skills in staff. However, as Ricciardi (2005) noted, these practices are not easily implemented in applied settings because it is not always possible to predict when the target competency needs to be demonstrated when managing low-frequency, but high intensity, problem behaviour. Instead, Ricciardi recommended role-play across a series of standardised scenarios, but it appears that this training approach has not been evaluated. Instead, Ricciardi (2005) suggested that role-play training based on standardised scenarios developed from actual behavioural episodes is a potential solution to this problem, but did not provide empirical support for this hypothesis.

Although necessary for overall care and safety of clients, much time devoted to staff training focuses on the fundamentals of care including ‘awareness’ training (e.g., autism and other developmental disabilities, child protection etc.), health and safety (e.g., food hygiene, fire evacuation procedures, first aid, etc.) and the use of physical interventions. Little training time is allocated to teaching staff behaviour management skills that are effective at reducing occurrences of actual problem behaviour (Cullen, 2000). MacDonald and McGill (2013)

reviewed the literature on training staff to effectively manage problem behaviour and reported that several studies only evaluated changes in staff knowledge, attributions and emotional responses, noting that improvements in these variables are unlikely to affect staff practice.

The current study describes the results of a training program that taught staff to role-play competency in the two specific responses identified by Mace et al. and Pritchard et al. via traditional verbal competency training, a card game played as a group, and then role-play training across a series of standardised scenarios developed directly from critical incidents that occurred in the school and in the community.

Method

Participants and Setting

Twenty direct care staff employed at the residential school were randomly selected from the entire pool of 36 staff to participate in the study as part of a school-wide training program that aimed to teach staff safe and effective ways of preventing problem behaviour from occurring. Ethical and governance approval for the research was given by the Bangor University School of Psychology Ethics and Research Committee (2013-10304). All staff involved in the study signed consent forms prior to their enrolment in the research.

Participant ages ranged from 25 to 62 years ($M = 36$) and their experience ranged from 0 to 18 years ($M = 4$). Ten were randomly assigned to the training group and ten served as the control group for Part 2 of the study. However, after initial group assignment, two staff in the control group were assigned to the training because they became available to receive training and two from the training group were randomly assigned to the control group to balance the numbers in both groups. There were five and six females in the training and control groups, respectively. All participants had received training courses in managing aggression, using physical interventions, and autism. The school provided residential care and

education for male students aged 11 to 19 years with mild intellectual disabilities, autism spectrum disorders and severe problem behaviour including aggression, serious property damage, absconding and sexually harmful behaviour. There were nine students that these 20 staff worked with over the 50 weeks of the study.

Experimental Design

The study was comprised of two parts, each with a different experimental design. Part 1 of the study evaluated the effects of training on staff responses to student requests for restricted activities during actual in-situ observations. Effects for the 10 participants who received training were evaluated using a pretest-posttest only group design. However, effects were demonstrated experimentally with a multiple baseline design for a subset of four of the 10 participants during the in-situ observations (see Figure 5.2). The experimental design for Part 2 was a randomized pretest-posttest control group design. This design evaluated the effects of training on the number of incidents of severe behaviour problems related to staff restricting access to a preferred activity prior to and after staff training as recorded on structured incident reports. The pretest assessment period averaged 5.7 months (range, 3.0 to 7.9) and the posttest period averaged 3.7 months (range, 3.0 to 4.6).

Target Behaviours, Incidents and Data Collection

The target behaviours for Part 1 were: (a) *staff providing an alternative choice (AC)* following a student's request for a restricted activity. For example, when a student requested access to a computer game, staff could say, "Mr. P is using the computer now, but we can play football outside or do some drawing together. Which would you like to do?"; (b) *staff saying 'yes' with a contingency (YC)* following a student's request for a restricted activity. For example, following a request for the computer game, staff could say, "Sure you can, just as soon as you finish cleaning your room."; (c) *staff saying 'no', providing an explanation, or distracting the student (NED)*; and (d) *student requests for restricted activities (RRA)*. One or

two trained observers collected data on the target behaviours using a count within 1-min interval recording procedure. Interobserver agreement, calculated on a point-by-point basis on 10% of the observations, averaged 97% (range, 83% to 100%).

In Part 2 of the study, incident reports were reviewed to identify incidents in which staff who were trained and control staff were directly involved in incidents of serious problem behaviour that was related to restricting access to a student's request for an activity that for some reason could not be provided at the time of the request. The two reasons for denying requests were: (a) the activity was unavailable, unsafe or expensive, and (b) a less preferred activity needed to be completed prior to beginning the requested activity. Incident reports were records of episodes of a student's problem behaviour and the circumstances surrounding the incident that were completed by the staff directly involved in the incident. The incident reports were collected 24 hr/day and consisted of detailed checklists of (a) 18 possible student behaviours that could have preceded the problem behaviour, (b) 42 possible topographies of problem behaviour, and (c) 8 possible events that may have motivated the problem behaviour (i.e., motivating operations). The incident reports also required a narrative description of the episode and identification of the staff and other students directly involved. For purposes of the present study, the dependent measure of interest was the number of behavioural incidents that were reportedly related to staff restricting a student's access to a preferred activity for each staff person who participated in the study. These records were converted to an incidents per month measure to allow comparison across varying pre- and post-training periods. The day following the incident, a senior supervisor interviewed the staff involved to assess the accuracy of the recorded information. This provided a measure of interobserver agreement and an opportunity for staff training (Pritchard et al., 2013).

Procedure—Part 1

Pre-training baseline. Staff were observed in the residential units as they interacted with the students. Three observation periods of 30 min duration in which at least one instance of a student's RRA occurred comprised the baseline phase. When an RRA was observed, data were collected on the staff person's response. As shown by Mace et al. (2011) and Pritchard et al. (2011), the preferred staff response to a student's RRA was either AC or YC. An NED response to a student's RRA has been shown to be associated with escalations in problem behaviour.

Staff training procedure. Staff were trained in groups of three or four in a single 6-hr session. The training consisted of four parts. First, the senior author gave a 1.5-hr to 2.0-hr PowerPoint™ presentation that reviewed how restricting access to preferred activities can motivate problem behaviour and result in escalating response class hierarchies (Lalli, Mace, Livesey & Wohn, 1995). The presentation then discussed three alternative ways to deny access to preferred activities, namely AC, YC and NED. Results from Mace et al. (2011) and Pritchard et al. (2011) were presented showing that the AC and YC procedures successfully avoided escalation of problem behaviour, whereas the NED response resulted in high levels of problem behaviour. Second, immediately following the PowerPoint™ presentation, a 10-question multiple choice quiz was administered to assess comprehension of the material covered. The quiz was then scored showing a mean 82% correct response rate (range, 70% to 90%). Incorrect responses were discussed and questions answered for 15 min. Third, from an analysis of actual incident reports at the school, 30 standardised scenarios were identified that led to episodes of serious problem behaviour when staff restricted access to preferred activities (e.g., computer games, food items, inappropriate DVDs, off-site activities, etc.). These standardised scenarios were printed on laminated playing cards that served as the basis for a question-and-answer card game lasting approximately 1 hr. For example, written on the

Table 5.1.

Standardised Scenarios

Scenario	Code	Example Response
It is a sunny Saturday afternoon in August. Dewi asks if he can take his roller skates to the promenade.	AC	'We can go to the skate park in town or the play area in school; you can choose'.
It's Thursday at 5pm and the office staff have all gone home. Twm asks you for all his savings out of the school safe.	YC	'Yes, when the office staff get here tomorrow'
Iwan is shopping with you in town. He picks up a DVD which has a parental advisory sticker on the front cover. He says 'I'm buying this DVD!'	AC	'You can buy this film or one of from the comedy section. You choose'
Alun is in the Co-op in town spending his pocket money on some sweets and a soft drink. He picks up two large bottles of Coke and says 'I'm buying these two bottles of Coke!'	AC	'You can buy apple or orange juice to go with your sweets. You choose'
It's 9am on a Saturday morning. Huw has just woken up. He comes out of his bedroom he says 'I'm going to town to spend my pocket money!'	YC	'Hi! Would you like a shower or bath before your breakfast. You choose'.
Dewi is in class and asks if he can take some of the school pens, paper and colouring pencils back to the houseroom.	YC	'Put some on the school shop and buy some when you have enough money'.
It is 8pm on a Sunday evening in June and Iwan asks you if he can go for a ride on his bike but it is not on his activity support plan.	AC	'We can play football or a game on your iPad; you choose'.
Ioan is out spending his pocket money in town and asks you if he can buy a water pistol.	AC	'Buy some Match Attax cards or a Pokemon game; you choose'
At 6.30pm Mel asks for his Xbox controller. His activity support plan says he can have it at 7pm after he has finished tidying his bedroom.	YC	'Sure you can. Just as soon as you've finished tidying your room'
It is 6pm. Gwion had been aggressive to staff earlier in the day but he is now calm. He is supposed to be drying the dishes, but he asks you if he can go and see the chickens.	YC	'Yes you can. Let's finish these dishes and we'll put our coats on'

card was, “Look at the player on your left and say: ‘J is watching a music channel and B asks if he can watch Eastenders.’ What would you say?” If the staff person answered with an appropriate AC or YC response, the trainers enthusiastically acknowledged the correct response. If there was an NED response to the question, the trainers provided corrective feedback and asked the group to identify a correct AC or YC response to the scenario. A sample of 10 of the 30 standardised scenarios is presented in Table 1. Fourth, staff responses to the 10 scenarios were role-played. Initially, two trainers role-played a scenario taken from the card game. The trainer playing the role of the staff provided a correct AC or YC response to the RRA scenario. Next, using the identical RRA scenario, each staff member in training played the role of the staff in the scenario, effectively imitating the correct model they had observed. The remaining nine scenarios were role played in which the staff in training played the role of the staff in the scenario. During and after each role play, the trainers provided praise or corrective feedback. Each staff in training role-played five to seven RRA scenarios. The quality of each staff person’s role play was ranked on a scale from 1 to 5 in five performance areas (see Table 5.2).

Table 5.2.

Role-play Score Sheet

Behaviour	1	2	3	4	5
Use of the correct YC/AC response					
Appear calm and adopt a non-confrontational manner					
Limit talk to a minimum and use easy to understand words					
No explanation/negotiation and ignore problem behaviour					
Respond appropriately when the student makes a safe choice					

- Key:
1. More instruction needed
 2. More practice needed
 3. Minimal correction needed—some work needed to meet target goals
 4. Targets achieved—good example to team members
 5. Exceeds expectations—excellent example to team members

The mean score for the 10 trainees was 4.6 (range, 4.0 to 4.9). Two trainers independently rated each participant's role play performance on all occasions. Exact agreement on rankings averaged 71%. Mean agreement +/- 1 rank was 95%.

Social Validity—Assessment of Training Experience

At the end of the study, staff were given a 20-item questionnaire adapted from Toogood (2008). Staff rated each item on a 5-point Likert scale from 1 = strongly disagree to 5 = strongly agree. All staff agreed or strongly agreed that they enjoyed the training experience, that they felt they were more able to prevent problem behaviour escalating, and that their level of confidence had improved. All staff strongly agreed that the training was well organized. Three of the ten participants strongly disagreed with the statement 'I enjoyed the role-play exercises'; the other seven staff agreed or strongly agreed that they enjoyed the role-play training.

Results

Results for Part 1 of the study are shown in Figures 5.1 and 5.2. Figure 5.1 presents the average percentage of naturally occurring RRAs that staff in the training group responded to with either an AC, YC, NED, and the total number of student RRAs during the three pre-training baseline and three post-training observations. Prior to training, AC and YC responses to RRAs were consistently low ($M = 18.0\%$).

By contrast, NED responses were consistently high averaging 82.0%. During in situ observations following staff training, the ordinal relation between AC/YC and NED reversed. AC or YC responses increased to an average of 72.0%, whereas the mean NED decreased to 28.0%. All staff showed increases in observed AC/YC, with an average improvement of 60.8%. However, two of the 10 staff only improved by 3% and 9%. Likewise, the average decrease in observed NED following training was 60.4%, although two staff only reduced NEDs by 8% and 9%. One-tailed dependent t-tests comparing AC/YC responses before and

after training showed a significant increase ($t = 5.455$, $df = 9$, $p = 0.0002$). The same t-tests performed on NED responses showed a significant decrease ($t = -5.452$, $df = 9$, $p = 0.0002$).

By contrast, prior to and after training there were no appreciable changes in the number of

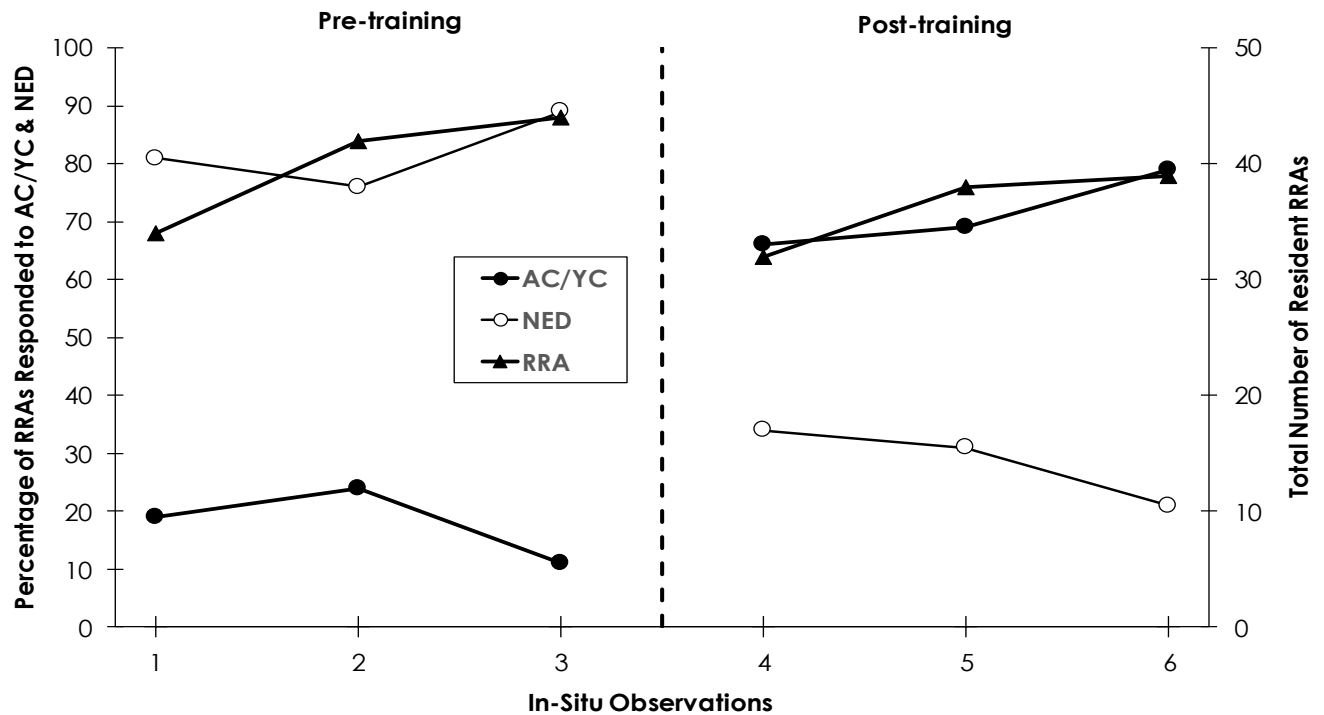


Figure 5.1. Percentage of requests for restricted activities (RRA) responded to by providing an alternative choice (AC) or saying yes and providing a contingency (YC), and the total number of student RRAs observed.

student RRAs (120 pre-training versus 109 post-training) suggesting that the changes in staff responses was not a function of lower levels of RRAs in the post-training observation period.

Because this was a field-based study conducted under natural and routine conditions in a residential school, training and pre-training and post-training observations were necessarily staggered across time. This permitted a multiple baseline design evaluation of the effects of training on four of the ten participants. Observations on the remaining six participants did not overlap in time to allow for a multiple baseline design test of the effects of training. Figure 5.2 presents the results of pre-training and post-training observations for

four participants staggered in a multiple baseline design. In each case, AC/YC responses are low and NED are high during observations prior to training. Following training, there is an immediate change in staff responses to student RRAs, and in all cases the ordinal position of

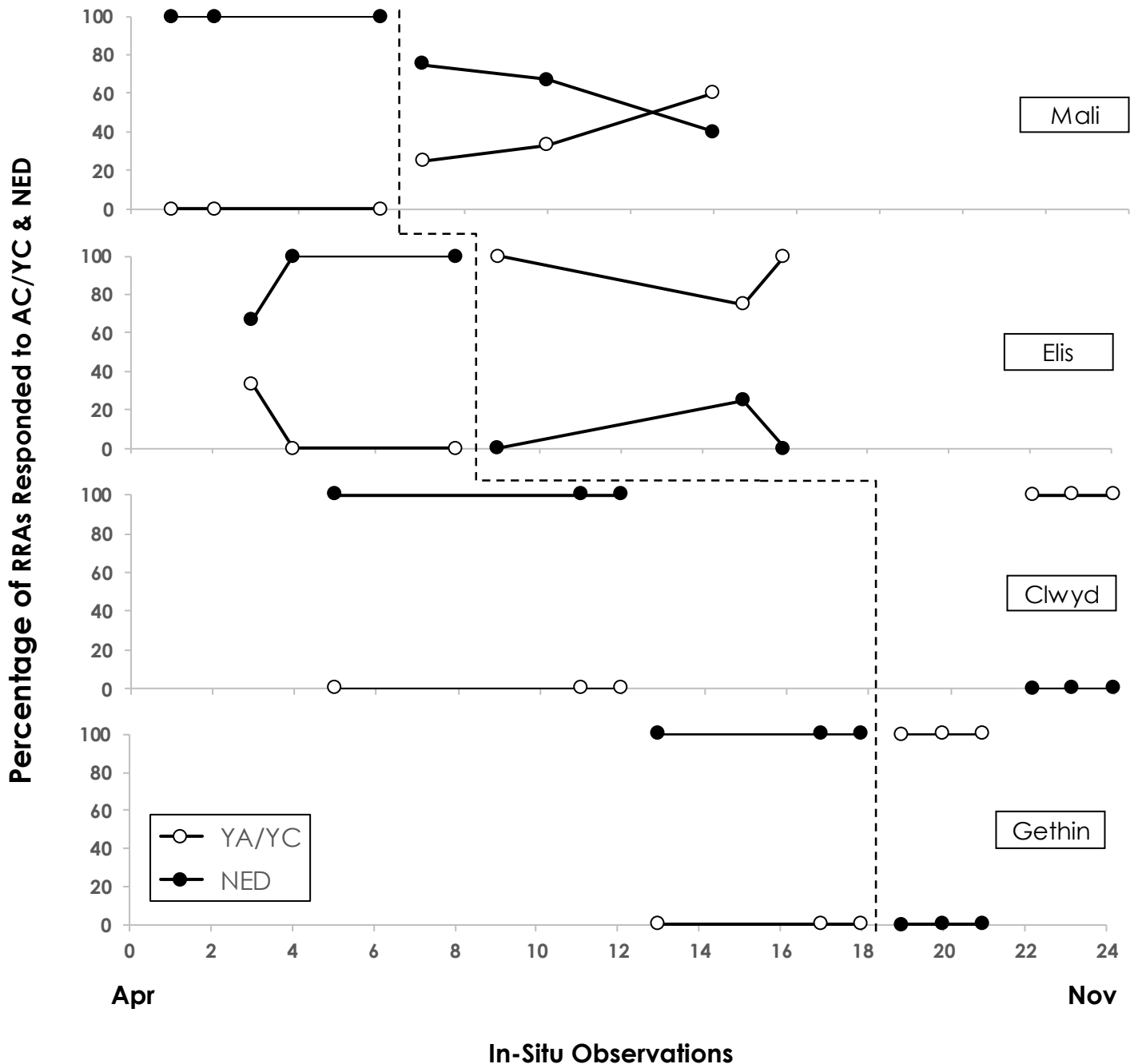


Figure 5.2. Percentage of requests for restricted activities (RRA) responded to by providing an alternative choice (AC), saying yes and providing a contingency (YC), and saying 'no', providing an explanation, or distracting a student from the request (NED) across in situ observations prior to and following staff training.

AC/YC and NED reversed following training.

Part 2 results compared the training and control groups on the number of incident reports in which staff were directly involved in episodes of serious problem behaviour related to restricting a student's access to a preferred activity. The groups were compared for the period prior to staff training using a two-tailed independent t-test. The pre-test means of the training group and the control group were 0.51 and 0.53 incidents per month, respectively, and were not statistically different ($t = 0.11$, $df = 18$, $p = 0.91$). Lack of differences at pre-training warranted a comparison of the groups during the post-training period. The mean of the training group dropped to 0.17 incidents per month representing a 67% reduction. By contrast, incident reports per month for the control group did not change in the training period ($M = 0.52$). The post-training differences were statistically significant using a one-tailed independent t-test ($t = 2.88$, $df = 18$, $p = 0.005$).

Discussion

The current research demonstrated that staff performance can be improved by using role-play exercises based on standardised scenarios conducted in a single 6-hr training session. In most cases, training produced immediate and marked changes in staff responses to RRAs during actual in-situ observations. In addition, staff who received training were involved in 67% fewer behavioural incidents related to restricting access to desired objects or activities while their peers who did not receive the training showed no change their involvement in related incident reports. This study is the first to use standardised scenarios in this way and to teach staff to respond to client RRAs in ways that have been shown in prior research to be effective. This was important because the prevalence of this problem was comparatively high with 35% of the incident reports at this residential school being related to RRAs.

The present results were durable for trained staff for a period of 3.0 to 4.6 months. Other researchers using brief in-vivo training in the form of praise and corrective feedback have reported it was necessary to maintain weekly feedback on videotaped performance and monetary incentives to implement treatment plans with high integrity (Courtemanche et al., 2014). One possible account of the durability of these effects may have been the intensity of the training procedures. The 3 to 4 participants in each training group had multiple opportunities to learn the correct responses to 30 standardised scenarios via the card game and then had extended practice in using those responses in the 10 subsequent role-play exercises (Reid & Parsons, 2002). Prior to the development of the current training program, staff had to rely on reading and learning risk assessment and management protocols and then put them into practice when a child made demands that could not, or should not, be met. Reid and Parsons (2002) noted that this is likely to lead to uncertainty during challenging situations rather than equip staff with a reliable and effective method of reducing the likelihood of problem behaviour escalating.

Based on the present study and Courtemanche et al. (2014), it appears that teaching staff to actually engage in the behaviour management skill that is required, either by role-playing or in-vivo training, may be necessary to translate a written behaviour management plan into effective behavioural intervention. Programs that care for individuals with problem behaviour and intellectual disabilities emphasize the importance of staff “reading”, “familiarizing”, and “knowing” behaviour management plans as a pre-requisite for effective behaviour management “in the moment” (Ravoux, Baker & Brown, 2012). We hypothesize that this emphasis may be misplaced because “knowing” may not translate into “doing” because the contingencies for staff demonstrating verbal competency may differ markedly from those that promote skilled behaviour management in the moment. Future research could practically test this view by directly comparing the effects of verbal competency, role-play or

in-vivo training, and the combination of verbal competency and role-play or in-vivo training on occurrences of serious problem behaviour. The results could point to better approaches to staff training that save time and perhaps enable resources to be better used elsewhere.

The current study found staff training via role-play during standardised scenarios is a safe, low-cost, and effective method of helping staff to respond effectively during situations that can lead to serious escalations of problem behaviour including aggression and property destruction. The present findings could be extended to develop standardised scenarios related to other motivating operations (e.g., attention and escape) that commonly evoke problem behaviour.

CHAPTER 6

GENERAL DISCUSSION

The collection of papers discussed here is comprised of a review of the literature relevant to BMT and three single-subject designs that examined the effects of alternating high- and low-rates of reinforcement on the reinstatement, resurgence and renewal of problem behaviour. The final paper reports the findings of a pilot staff training programme that helped staff develop the skills to respond more effectively when faced with demands they cannot meet by children and young people with IDD, thus avoiding the recurrence of severe problem behaviour.

Treatment relapse is the recurrence of problem behaviour following apparently successful treatment. Despite the success of many interventions based on applied behaviour analysis (e.g., TCS and differential reinforcement) there has been little attention given to treatment relapse other than that given to failures in treatment integrity (i.e., the degree to which a treatment is implemented as designed). However, recent investigations by basic researchers utilising BMT have suggested that the magnitude of the reinstatement, resurgence and renewal of problem behaviour may be reduced by using low-rate treatment rather than high-rate treatment.

TCS and treatments based on differential reinforcement (e.g., DRA and DRO) are commonly used interventions that have been shown to successfully reduce problem behaviour. However, BMT research has shown that these two interventions have the side-effect of making problem behaviour more resistant to change because these treatments add reinforcement to the stimulus context in which the behaviour has a history of being reinforced. For example, treatments based on TCS increase persistence because reinforcement is added independently of the problem behaviour, and DRA because reinforcement is used to increase the rate of an alternative behaviour that competes with the

problem behaviour. DRO intervals are usually arranged so that the participant contacts frequent reinforcement in the absence of problem behaviour. In summary, BMT research has demonstrated that the magnitude of the relapse of problem behaviour is greater in contexts associated with high rates of reinforcement compared to low rates of reinforcement.

The translation of Podlesnik & Shahan's (2009) reinstatement experiment discussed in Chapter 3 was conducted with a 16 year-old male participant who presented severe aggression and disruption that was maintained by attention (Pritchard et al., 2014). Problem behaviour was, as expected, successfully treated by two therapists who delivered attention contingent on appropriate requests for attention made by the participant concurrent with non-contingent attention. Treatment was delivered at differing rates by the two therapists. Therapist 1 delivered attention on a VI VT 30-s schedule and Therapist 2 on a VI VT 120-s schedule. Interestingly, both treatment schedules resulted in similar reductions in the rate of problem behaviour. During the reinstatement phase (i.e., a return to the baseline condition) problem behaviour recurred. As predicted by BMT, the relapse of problem behaviour was greater in the schedule associated with high rate reinforcement (i.e., with Therapist 1). This is an important finding as it suggests that high rate reinforcement can lead to greater magnitudes of treatment relapse when treatment is later compromised in some way.

Sweeney and Shahan (2013) demonstrated that the resurgence of a target behaviour is reduced if the alternative behaviour that replaced the target behaviour is established using low rate reinforcement compared to high rate reinforcement. In the resurgence component of the Pritchard et al. (2014) study the attention-maintained problem behaviour of the 16 year-old participant was again reduced by a return to the successful treatment schedule (i.e., VI VT 30-s, VI VT 120-s). Again, despite the differing rates of reinforcement during the treatment phase, problem behaviour was reduced to comparable levels. An extinction condition was then introduced during which all behaviour, problem and appropriate, was ignored by both

therapists in two separate extinction sessions. Problem behaviour resurged with both therapists, but was greater with Therapist 1 (i.e., the therapist who had delivered the high rate treatment condition). Although counter-intuitive, this finding is predicted by BMT and is relevant for practitioners because it suggests that high rate treatment schedules may result in greater treatment relapse during failures in treatment integrity.

The final relapse experiment described in Chapter 4 was an ABA renewal design that used alternating schedules of reinforcement (i.e., VI VT 30-s, VI VT 120-s) to investigate the effects of renewal on attention-maintained problem behaviour presented by an 18-year-old male. Context A was a classroom painted orange. Once comparable levels of responding had been achieved the participant was then transferred to a classroom painted blue (i.e., context B) not correlated with reinforcement for problem behaviour. There were no episodes of problem behaviour Context B with Therapist 1 and only low rates of responding with Therapist 2. The participant was then transferred back to the orange classroom. Problem behaviour was renewed immediately on the participant's return to the orange classroom. Like the reinstatement and resurgence experiments described in Chapter 3, the magnitude of relapse was greater with the stimuli associated with the greater rate of reinforcement (i.e., Therapist 1), a finding that contradicts much of what is commonly believed by practitioners working in applied settings (i.e., that high rate reinforcement is essential to maintain successful treatment outcomes). These findings support the findings of the reinstatement and resurgence studies described in Chapter 3 (i.e., that low and high rates of reinforcement reduce rates of problem behaviour to comparable levels and that the magnitude of treatment relapse is greater following high rate reinforcement compared to low rate reinforcement). However, what is of interest in this experiment is that the reinforcer maintaining the behaviour was not reintroduced (as in the reinstatement model), and neither was treatment integrity compromised in some way (as in the resurgence model). It was sufficient for the

participant to re-enter Context A for the behaviour to be renewed. It is surprising that translational and applied researchers have not investigated the ABA renewal model more thoroughly as it is analogous to a client with IDD presenting problem behaviour at home, receiving treatment in a clinic and then returning home (see Lalli et al., 1997). This is a relapse model that deserves further attention.

The BMT discussion paper (Pritchard et al., 2014) and the single-subject designs (Pritchard et al., 2014; Pritchard et al., under review) are examples of collaboration between basic and applied researchers (i.e., translational research) in the US and the UK. The consistent finding that low-rate reinforcement schedules for problem behaviour leads to more durable treatment effects is counter-intuitive. A second interesting finding from the three studies is that both treatment schedules (i.e., low- and high-rate) were as effective in reducing the rate of problem behaviour in the three experiments. Again, this is a counter-intuitive finding; most practitioners assume that high rates of reinforcement for an alternative behaviour will be more effective than low-rate reinforcement. These three studies are preliminary, but the findings suggest that low-rate treatment options should be considered when designing behavioural interventions.

The fourth study described in Chapter 5 investigated how treatment integrity could be improved to avoid problem behaviour when students with IDD demanded access to activities that could not be provided (Pritchard et al., 2015). The study was based on Mace et al. (2011) and Pritchard et al. (2011), two studies carried out previously in the same setting as the current research. Those studies, both single-case designs, reported that two male students would frequently present problem behaviour immediately on entry to their classrooms, thus requiring staff to safely manage episodes of challenging behaviour rather than start the lesson on time or attend to the other students. This behaviour affected their engagement in scheduled classroom activities and put teachers, other staff and their peers at risk of injury from their

aggression. In both studies, a concise verbal response, concurrent with the presentation of a scheduled academic or domestic task or the offer of an alternative activity were shown to be effective in reducing the severity and frequency of problem behaviour compared with just saying 'no' concurrent with distraction or an explanation.

The training component of the research was preceded by direct observation of staff in the training group. Each staff member was observed working with the students for three 30 minute sessions. Following training, direct observation of the trained participants demonstrated that most of the group were more likely to use the correct response to student demands, and that fewer episodes of problem behaviour occurred with trained staff as a result. In addition, analysis of incident reports prior to training showed that there was no difference in the rate of incidents for the training or control group. However, post-training there was a reduction of 67% in the training group whereas the rate of incidents for the control group remained approximately the same. This study is the first to use role-play based on standardised scenarios and the findings suggest that it is an effective and economical method of training staff.

The four experiments described above are socially significant because they point towards solutions to the relapse of problem behaviour presented by clients with IDD. Firstly, the finding that treatments using high-rate reinforcement are more likely to be associated with post-treatment relapse is important because historically it has been assumed that high-rate reinforcement leads to more durable effects. Secondly, the finding that low-rate reinforcement is as effective during treatment in reducing rates of problem behaviour as high-rate reinforcement suggests that clinicians should design treatment programmes utilising low-rate reinforcement, especially so that low-rate treatment programmes are associated with greater treatment integrity. Thirdly, staff working with people with intellectual disabilities are often poorly trained and poorly supported, but the fourth experiment described above

demonstrated that role-play training based on standardised scenarios is an effective method of training staff and leads to high levels of post-training treatment integrity.

The reinstatement, resurgence and renewal studies presented here are significant because they suggest that the magnitude of the relapse of problem behaviour can be reduced if low-rate behaviour is used to treat attention-maintained behaviour. Reinstatement and resurgence occurred following successful treatment when treatment integrity was compromised. In contrast, ABA renewal of problem behaviour occurred simply as a consequence of the participant returning to the stimulus context that was associated with a history of reinforcement for problem behaviour. This finding is worthy of further investigation by both applied and translational researchers because it is an analogue of frequently observed relapse following clinic-based treatment for problem behaviour presented by clients with IDD.

References

- Ahearn, W. H., Clark, K. M., Gardenier, N. C., Chung, B. I., & Dube, W. V. (2003). Persistence of stereotypic behavior: Examining the effects of external reinforcers. *Journal of Applied Behavior Analysis, 36*, 439-448. doi: 10.1901/jaba.2003.36-439
- Allen, K. D., & Warzak, W. J. (2000). The problem of parental nonadherence in clinical behavior analysis: Effective treatment is not enough. *Journal of Applied Behavior Analysis, 33*, 373-391. doi: 10.1901/jaba.2000.33-373
- Bandarian Balooch, S., & Neumann, D. L. (2011). Effects of multiple contexts and context similarity on the renewal of extinguished conditioned behaviour in an ABA design with humans. *Learning and Motivation, 42*, 53-63. doi: 10.1016/j.lmot.2010.08.008
- Berry, M. S., Sweeney, M. M., & Odum, A. L. (2014). Effects of baseline reinforcement rate on operant ABA and ABC renewal. *Behavioural Processes, 108*, 87-93.
- Bouton, M. E. (2000). A learning theory perspective on lapse, relapse and the maintenance of behavior change. *Health Psychology, 19*, 57-63.
- Bouton, M. E. (2002). Context, ambiguity, and unlearning: Sources of relapse after behavioral extinction. *Biological Psychiatry, 52*, 976-986.
- Bouton, M. E. (2004). Context and behavioral processes in extinction. *Learning & Memory, 11*, 485-494. doi: 10.1101/lm.78804
- Bouton, M. E. & Swartzentruber, D. (1991). Sources of relapse after extinction in Pavlovian and instrumental learning. *Clinical Psychology Review, 11*, 123-140.
- Bouton, M. E., Todd, T. P., Vurbic, D., & Winterbauer, N. E. (2011). Renewal after the extinction of free operant behavior. *Learning & Behavior, 39*, 57-67.
doi: 10.3758/s13420-011-0018-6

- Broadhurst, S., & Mansell, J. (2007). Organizational and individual factors associated with breakdown of residential placements for people with intellectual disabilities. *Journal of Intellectual Disability Research, 51*, 293-301.
doi: 10.1111/j.1365-2788.2006.00876.x
- Brownell, K. D., Marlatt, G. A., Lichenstein, E., & Wilson, G. T. (1986). Understanding and preventing relapse. *American Psychologist, 41*, 765-782.
- Carr, J. E., Coriaty, S., Wilder, D. A., Gaunt, B. T., Dozier, C. L., Britton, L. N., ... Reed, C. L. (2000). A review of "noncontingent" reinforcement as treatment for the aberrant behavior of individuals with developmental disabilities. *Research in Developmental Disabilities, 21*, 377-391.
- Carr, E. G. & Durand, V. M. (1985). Reducing behavior problems through functional behaviour training. *Journal of Applied Behavior Analysis, 18*, 111-126.
- Chowdhury, M., & Benson, B. A. (2011). Use of differential reinforcement to reduce behavior problems in adults with intellectual disabilities: A methodological review. *Research in Developmental Disabilities, 32*, 383-394.
doi: 10.1016/j.ridd.2010.11.015
- Cohen, S. L. (1996). Behavioral momentum of typing behavior in college students. *Journal of Behavior Analysis and Therapy, 1*, 36-51.
- Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior Analysis*, (2nd Edition). Saddle River, NJ: Pearson Education.
- Courtemanche, A., Sheldon, J., Sherman, J., Schroeder, S., Bell, B., & House, R. (2014). Assessing the effects of a staff training package on the treatment integrity of an intervention for self-injurious behaviour. *Journal of Developmental and Physical Disabilities. doi: 10.1007/s10882-014-9372-6*

- Cullen, C. (2000). *A review of some important issues in research and services for people with learning disabilities and challenging behaviour*. Scottish Executive: Edinburgh.
- Crombag, H. S., & Shaham, Y. (2002). Renewal of drug seeking by contextual cues after prolonged extinction in rats. *Behavioral Neuroscience, 116*, 169-173.
doi: 10.1037/0735-7044.116.1.169
- DeLeon, I. G., Williams, D., Gregory, M. K., & Hagopian, L. P. (2005). Unexamined potential effects of the noncontingent delivery of reinforcers. *European Journal of Behavior Analysis, 6*, 57-69.
- Denniston, J. C., Chang, R. C., & Miller, R. R. (2003). Massive extinction treatment attenuates the renewal effect. *Learning and Motivation, 34*, 68-86.
doi: 10.1016/S0023-9690(02)00508-8
- Doughty, A. H., & Oken, G. (2008). Extinction-induced response resurgence: A selective review. *The Behavior Analyst Today, 9*, 27-33.
- Doughty, A. H., Reed, P., & Lattal, K. A. (2004). Differential reinstatement predicted by preextinction response rate. *Psychonomic Bulletin & Review, 11*, 1118-1123.
doi: 10.3758/BF03196746
- Dube, W. V., Ahearn, W. H., Lionello-DeNolf, K., & McIlvane, W. J. (2009). Behavioral momentum: Translational research in intellectual and developmental disabilities. *The Behavior Analyst Today, 10*, 238 -253.
- Epstein, R. (1983). Resurgence of previously reinforced behavior during extinction. *Behaviour Analysis Letters, 3*, 391-397.
- Fisher, W., Piazza, C., Cataldo, M., Harrell, R., Jefferson, G., & Conner, R. (1993). Functional communication training with and without extinction and punishment. *Journal of Applied Behavior Analysis, 26*, 23-36. doi: 10.1901/jaba.1993.26-23

- Fiske, K. E. (2008). Treatment integrity of school-based behaviour analytic interventions: A review of the research. *Behavior Analysis in Practice, 1*, 19-25.
- Franks, G. J., & Lattal, K. A. (1976). Antecedent reinforcement schedule training and operant response reinstatement in rats. *Animal Learning and Behavior, 4*, 374-378.
doi: 10.3758/BF03214424
- Grimes, J. A., & Shull, R. L. (2001). Response-independent milk delivery enhances persistence of pellet-reinforced lever pressing by rats. *Journal of the Experimental Analysis of Behavior, 76*, 179-194. doi: 10.1901/jeab.2001.76-179
- Hagopian, L. P., Wilson, D. M., & Wilder, D. A. (2001). Assessment and treatment of problem behaviour maintained by escape from attention and access to tangible items. *Journal of Applied Behavior Analysis, 34*, 229-232.
- Hanson, R. K. & Bussiere, M. T. (1998). Predicting relapse: A meta-analysis of sexual offender recidivism studies. *Journal of Consulting and Clinical Psychology, 66*, 348-362. doi: 10.1037/0022-006X.66.2.348
- Hanson, R. K. & Morton-Bourgon, K. (2004). Predictors of sexual recidivism: An updated meta-analysis (2004-02). Ottawa, Canada: Public Safety and Emergency Preparedness Canada.
- Harchik, A. E., & Campbell, A. R. (1998). Supporting people with developmental disabilities in their homes: The role of organizational behavioral management. *Journal of Organizational Behavior Management, 18*, 83-101.
- Harper, D. N. (1999). Drug-induced changes in responding are dependent on baseline stimulus-reinforcer contingencies. *Psychobiology, 27*, 95-104.
- Hastings, R. P. (1996). Staff strategies and explanation for intervening with challenging behaviours. *Journal of Intellectual Disability Research, 40*, 166-175.

- Igaki, T., & Sakagami, T. (2004). Resistance to change in goldfish. *Behavioural Processes*, 66, 139-152. doi: 10.1016/j.beproc.2004.01.009
- Kelley, M. E., Liddon, C. J., Ribeiro, A., Greif, A. E. & Podlesnik, C. A. (2015). Basic and translational evaluation of renewal of operant responding. *Journal of Applied Behavior Analysis*, 48, 390-401. doi: 10.1002/jaba.209
- Lalli, J. S., Casey, S. D., & Kates, K. (1997). Noncontingent reinforcement as treatment for severe problem behavior: Some procedural variations. *Journal of Applied Behavior Analysis*, 30, 127-137. doi: 10.1901/jaba.1997.30-127
- Lalli, J. S., Mace, F. C., Wohn, T., & Livezey, K. (1995). Identification and modification of a response class hierarchy. *Journal of Applied Behavior Analysis*, 28, 551-559.
- LaVigna, G., Willis, T. J., Shaul, J. F., Abedi, M. & Sweitzer, M. (1994). *The Periodic Service Review: A Total Quality Assurance System for Human Services and Education*. Baltimore: Paul H. Brookes.
- Lattal, K. A., & St. Peter Pipkin, C. (2009). Resurgence of previously reinforced responding: Research and application. *The Behavior Analyst Today*, 10(2), 254-266.
- Leitenberg, H., Rawson, R. A., & Bath, K. (1970). Reinforcement of competing behavior during extinction. *Science*, 169, 301-303. doi: 10.1126/science.169.3942.301
- Leitenberg, H., Rawson, R. A., & Mulick, J. A. (1975). Extinction and reinforcement of alternative behavior. *Journal of Comparative and Physiological Psychology*, 88, 640-652. doi: 10.1037/h0076418
- Lieving, G. A., Hagopian, L. P., Long, E. S., & O'Connor, J. (2004). Response-class hierarchies and resurgence of severe problem behavior. *The Psychological Record*, 54, 621-634.

- Lieving, G. A., & Lattal, K. A. (2003). Recency, repeatability and reinforcer retrenchment: An experimental analysis of resurgence. *Journal of the Experimental Analysis of Behavior*, *80*, 217-233. doi: 10.1901/jeab.2003.80-217
- Lindberg, J. S., Iwata, B. A., Kahng, S., & DeLeon, I. G. (1999). DRO contingencies: An analysis of variable momentary schedules. *Journal of Applied Behavior Analysis*, *32*, 123-136. doi: 10.1901/jaba.1999.32-123
- Lionello-DeNolf, K. M., Dube, W. V., & McIlvane, W. J. (2010). Evaluation of resistance to change under different disrupter conditions in children with autism and severe intellectual disability. *Journal of the Experimental Analysis of Behavior*, *93*, 369-383. doi: 10.1901/jeab.2010.93-369
- MacDonald, J. M., Ahearn, W. H., Parry-Cruwys, D., & Bancroft, S. (2013). Persistence during extinction: Examining the effects of continuous and intermittent reinforcement on problem behavior. *Journal of Applied Behavior Analysis*, *46*, 333-338.
- MacDonald, A. & McGill, P. (2013). Outcomes of staff training in positive behaviour support: A systematic review. *Journal of Developmental and Physical Disabilities*, *25*, 17-33.
- Mace, F. C. (2000). Clinical applications of behavioral momentum. *Behavioral and Brain Sciences*, *23*, 105-106. doi: 10.1017/S0140525X00372405
- Mace, F. C., & Critchfield, T. S. (2010). Translational research in behavior analysis: Historical traditions and imperative for the future. *Journal of the Experimental Analysis of Behavior*, *93*, 293-312. doi: 10.1901/jeab.2010.93-293
- Mace, F. C., & Lalli, J. S. (1991). Linking descriptive and experimental analyses in the treatment of bizarre speech. *Journal of Applied Behavior Analysis*, *24*, 553-562. doi: 10.1901/jaba.1991.24-553

- Mace, F. C., Lalli, J. S., Shea, M. C., Lalli, E. P., West, B. J., Roberts, M., & Nevin, J. A. (1990). The momentum of human behavior in a natural setting. *Journal of the Experimental Analysis of Behavior, 54*, 163-172.
doi: 10.1901/jeab.1990.54-163
- Mace, F. C., Mauro, B. C., Boyajian, A. E., & Eckert, T. L. (1997). Effects of reinforcer quality on behavioral momentum: Coordinated applied and basic research. *Journal of Applied Behavior Analysis, 30*, 1-20. doi: 10.1901/jaba.1997.30-1
- Mace, F. C., McComas, J. J., Mauro, B. C., Progar, P. R., Taylor, B., Ervin, R., & Zangrillo, A. N. (2009). The persistence strengthening effects of DRA: An illustration of bidirectional translational research. *The Behavior Analyst, 32*, 293-300.
- Mace, F. C., McComas, J. J., Mauro, B. C., Progar, P. R., Taylor, B., Ervin, R., & Zangrillo, A. N. (2010). Differential reinforcement of alternative behavior increases resistance to extinction: Clinical demonstration, animal modeling, and clinical test of one solution. *Journal of the Experimental Analysis of Behavior, 93*, 349-367.
doi: 10.1901/jeab.2010.93-349
- Mace, F.C., Pratt, J.L., Prager, K., Thomas, K. & Pritchard, D. (2011). An evaluation of three methods of 'saying no' to avoid an escalating response class hierarchy. *Journal of Applied Behavior Analysis, 44*, 83-94.
- Mace, F. C., & Nevin, J. A. (in press). Maintenance, generalization and treatment relapse: A behavioral momentum theory analysis. *Education and Treatment of Children*.
- Mace, F. C. & Roberts, M. L. (1993). Factors affecting selection of behavioral interventions. In J. Reichle & D. P. Wacker (Eds), *Communicative alternatives to challenging behaviour: Integrating functional assessment and intervention strategies* (pp. 113-133). Baltimore, MD: Paul H. Brookes Publishing.

- Mace, F. C., Zangrillo, A. N., Prager, K., Carolan, E., Hoerger, M., Thomas, K., & Pritchard, D. (2008). A methodology for maintaining low levels of attention-maintained problem behaviors following variable-time schedule thinning. *European Journal of Behavior Analysis, 9*, 149-156.
- Mauro, B. C., & Mace, F. C. (1996). Differences in the effect of Pavlovian contingencies upon behavioral momentum using auditory versus visual stimuli. *Journal of the Experimental Analysis of Behavior, 65*, 389-399. doi: 10.1901/jeab.1996.65-389
- Milo, J. S., Mace, F. C., & Nevin, J. A. (2010). The effects of constant versus varied reinforcers on preference and resistance to change. *Journal of the Experimental Analysis of Behavior, 93*, 385-394. doi: 10.1901/jeab.2010.93-385
- Moore, T.R., & Symons, F. J. (2009). Adherence to behavioral and medical treatment recommendations by parents of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*, 1173-1184.
doi: 10.1007/s10803-009-0729-0
- Nakajima, S., Urushihara, K., & Masaki, T (2002). Renewal of operant performance formerly eliminated by omission or noncontingency training upon return to the acquisition context. *Learning and Motivation, 33*, 510-525.
doi: 10.1016/S0023-9690(02)00009-7
- Nakajima, S., Tanaka, S., Urushihara, K., & Imada, H. (2000). Renewal of extinguished lever-press responses upon return to the training context. *Learning and Motivation, 31*, 416-431. doi: 10.1006/lmot.2000.1064
- Nelson, J. B., Sanjuan, M. D. C., Vadillo-Ruiz, S., Pérez, J., & León, S. P. (2011). Experimental renewal in human participants. *Journal of Experimental Psychology: Animal Behavior Processes, 37*, 58-70. doi: 10.1037/a0020519

- Neumann, D. L. (2006). The effects of physical context changes and multiple extinction contexts on two forms of renewal in a conditioned suppression task with humans. *Learning and Motivation, 37*, 149-175. doi: 10.1016/j.lmot.2005.06.004
- Nevin, J. A. (1974). On the form of the relation between response rates in a multiple schedule. *Journal of the Experimental Analysis of Behavior, 21*, 237-248. doi: 10.1901/jeab.1974.21-237
- Nevin, J. A. (1984). Pavlovian determiners of behavioural momentum. *Animal Learning & Behavior, 12*, 363-370. doi: 10.3758/BF03199981
- Nevin, J. A. (1992). An integrative model for the study of behavioral momentum. *Journal of the Experimental Analysis of Behavior, 57*, 301-316. doi: 10.1901/jeab.1992.57-301
- Nevin, J. A. (2002). Measuring behavioral momentum. *Behavioural Processes, 57*, 187-198. doi: 10.1016/S0376-6357(02)00013-X
- Nevin, J. A., & Grace, R. C. (2000). Behavioral momentum and the Law of Effect. *Behavioral and Brain Sciences, 23*, 73-130. doi: 10.1017/S0140525X00002405
- Nevin, J. A., Grace, R. C., Holland, S., & McLean, A. P. (2001). Variable-ratio versus variable-interval schedules: Response rate, resistance to change, and preference. *Journal of the Experimental Analysis of Behavior, 76*, 43-74. doi: 10.1901/jeab.2001.76-43
- Nevin, J. A., Mandell, C., & Atak, J. R. (1983). The analysis of behavioral momentum. *Journal of the Experimental Analysis of Behavior, 39*, 49-59. doi: 10.1901/jeab.1983.39-49
- Nevin, J. A., McLean, A. P., & Grace, R. C. (2001). Resistance to extinction: Contingency termination and generalization decrement. *Animal Learning & Behavior, 29*, 176-191. doi: 10.3758/BF03192826

- Nevin, J. A., & Shahan, T. A. (2011). Behavioral momentum theory: Equations and applications. *Journal of Applied Behavior Analysis, 44*, 877-895.
doi: 10.1901/jaba.2011.44-877
- Nevin, J. A., Tota, M. E., Torquato, R. D., & Shull, R. L. (1990). Alternative reinforcement increases resistance to change: Pavlovian or operant contingencies? *Journal of the Experimental Analysis of Behavior, 53*, 359-379. doi: 10.1901/jeab.1990.53-359
- Nevin, J. A., & Wacker, D. P. (2013). Response strength and persistence. In G. J. Madden (Ed.). *APA Handbook of Behavior Analysis: Volume 2*. Washington, DC: American Psychological Association.
- Newton, I. (1848). *Newton's principia: The mathematical principles of natural philosophy* (A. Mott, Trans.). New York: D. Adee. (Original work published 1686).
- Northup, J., Fisher, W., Kahng, S. W., Harrell, R., & Kurtz, P. (1997). An assessment of the necessary strength of behavioral treatments for severe behavior problems. *Journal of Developmental and Physical Disabilities, 9*, 1-16. doi: 10.1023/A:1024984526008
- Okouchi, H., & Lattal, K. A. (2006). An analysis of reinforcement history effects. *Journal of the Experimental Analysis of Behavior, 86*, 31-42. doi: 10.1901/jeab.2006.75-05
- Osnes, P. G., & Lieblein, T. (2003). An explicit technology of generalization. *The Behavior Analyst Today, 3*, 364-374.
- Parry-Cruwys, D. E., Neal, C. M., Ahearn, W. H., Wheeler, E. E., Premchander, R., Loeb, M. B., & Dube, W. V. (2011). Resistance to disruption in a classroom setting. *Journal of Applied Behavior Analysis, 44*, 363-367. doi: 10.1901/jaba.2011.44-363
- Petscher, E. S., Rey, C., & Bailey, J. S. (2009). A review of empirical support for differential reinforcement of alternative behaviour. *Research in Developmental Disabilities, 30*, 409-425.
- Podlesnik, C.A., Jimenez-Gomez, C., & Shahan, T.A. (2006). Resurgence of alcohol seeking

- produced by discontinuing non-drug reinforcement as an animal model of drug relapse. *Behavioural Pharmacology*, *17*, 369-374.
- doi: 10.1097/01.fbp.0000224385.09486.ba
- Podlesnik, C. A., Bai, J. Y. H., & Elliffe, D. (2012). Resistance to extinction and relapse in combined stimulus contexts. *Journal of the Experimental Analysis of Behavior*, *98*, 169-189. doi: 10.1901/jeab.2012.98-169
- Podlesnik, C. A., & Shahan, T. A. (2008). Response–reinforcer relations and resistance to change. *Behavioural Processes*, *77*, 109-125. doi: 10.1016/j.beproc.2007.07.002
- Podlesnik, C. A., & Shahan, T. A. (2009). Behavioral momentum and relapse of extinguished operant responding. *Learning and Behavior*, *37*, 357-364.
- doi: 10.3758/LB.37.4.357
- Poling, A. & Normand, M. (1999). Non-contingent reinforcement: An inappropriate description of time-based schedules that reduce behavior. *Journal of Applied Behavior Analysis*, *32*, 237-238. doi: 10.1901/jaba.1999.32-237
- Pritchard, D., Hoerger, M., Dyer, T., Graham, N, Penney, H. & Mace, F. C. (2013) Sodium valproate withdrawal correlates with reduced aggression. *British Journal of Learning Disabilities*, *42*, 162-167. doi:10.1111/bld.12019
- Pritchard, D., Hoerger, M., & Mace, F. C. (2014). Treatment relapse and behavioral momentum theory. *Journal of Applied Behavior Analysis*, *47*, 814-833. doi: 10.1002/jaba.163
- Pritchard, D, Hoerger, M., Mace, F. C., Ikin, A, Kochy, J., Thomas, K. & Penney, H. (2011). An evaluation of three methods of denying access to computers to a person with learning disabilities. *European Journal of Behavior Analysis*, *12*, 395-402.
- Pritchard, D., Hoerger, M., Mace, F. C., Penney, H., & Harris, B. (2014). Clinical translation of animal models of treatment relapse. *Journal of the Experimental Analysis of*

Behavior, 101, 442-449. doi: 10.1002/jeab.87

- Pritchard, D., Hoerger, M., Penney, H., Eiri, Ll., Fothergill, S., Hellowell, L., & Mace, F. C. (2015). Training staff to avoid problem behavior related to restricting access to preferred activities. *Behavior Analysis in Practice*. doi: 10.1007/s40617-015-0061-4
- Pritchard, D., Hoerger, M., Penney, H., Eiri, Ll., Harris, B. & Mace, F. C. (in preparation). Clinical translation of the ABA renewal model of treatment relapse.
- Pyszczynski, A. D., & Shahan, T. A. (2011). Behavioral momentum and relapse of ethanol seeking: Non-drug reinforcement in a context increases relative reinstatement. *Behavioural Pharmacology, 22*, 81-86. doi: 10.1097/FBP.0b013e328341e9fb
- Quick, S. L., Pyszczynski, A. D., Colston, K. A., & Shahan, T. A. (2011). Loss of alternative non-drug reinforcement induces relapse of cocaine-seeking in rats: Role of dopamine D₁ receptors. *Neuropsychopharmacology, 36*, 1015-1020. doi: 10.1038/npp.2010.239
- Ramirez, A. J., Craig, T. K., Watson, J. P., Fentiman, I. S., North, W. R., & Rubens, R. D. (1989). Stress and relapse of breast cancer. *British Medical Journal, 298*, 291-293. doi: 10.1136/bmj.298.6669.291
- Ravoux, P., Baker, P. & Brown, H. (2012). Thinking on your feet: Understanding the immediate responses of staff to adults who challenge intellectual disability services. *Journal of Applied Research in Intellectual Disabilities, 25*, 189-202.
- Reed, P., & Doughty, A. H. (2005). Within-subject testing of the signalled-reinforcement effect on operant responding as measured by response rate and resistance to change. *Journal of the Experimental Analysis of Behavior, 83*, 31-45. doi: 10.1901/jeab.2005.69-02
- Reed, P., & Morgan, T. A. (2007). Resurgence of behavior during extinction depends on previous rate of response. *Learning & Behavior, 35*, 106-114. doi: 10.3758/BF03193045

- Reid, R. L. (1958). The role of the reinforcer as a stimulus. *British Journal of Psychology*, *49*, 202-209. doi: 10.1111/j.2044-8295.1958.tb00658.x
- Reid, D. H., & Parsons, M. B. (2002). Working with staff to overcome challenging behavior among people who have severe disabilities. Morganton, NC: Habilitative Management Consultants, Inc.
- Ricciardi, J. N. (2005). Achieving human service outcomes through competency-based training: A guide for managers. *Behaviour Modification*, *29*, 488-507
- Shaham, Y., Shalev, U., Lu, L., de Wit, H., & Stewart, J. (2003). The reinstatement model of drug relapse: History, methodology and major findings. *Psychopharmacology*, *168*, 3-20. doi: 10.1007/s00213-002-1224-x
- Shahan, T. A., & Burke, K. A. (2004). Ethanol-maintained responding of rats is more resistant to change in a context with added non-drug reinforcement. *Behavioural Pharmacology*, *15*, 279-285. doi: 10.1097/01.fbp.0000135706.93950.1a
- Shahan, T. A., & Sweeney, M. M. (2011). A model of resurgence based on behavioral momentum theory. *Journal of the Experimental Analysis of Behavior*, *95*, 91-108. doi: 10.1901/jeab.2011.95-91
- Silverman, K., DeFulio, A., & Sigurdsson, S. O. (2012). Maintenance of reinforcement to address the chronic nature of drug addiction. *Preventive Medicine*, *55*, S46-S53.
- Solinas, M., Chauvet, C., Thiriet, N., El Rawas, R., & Jaber, M. (2008). Reversal of cocaine addiction by environmental enrichment. *Proceedings of the National Academy of Sciences of the United States of America*, *105*, 17145-17150. doi: 10.1073/pnas.0806889105
- Spradlin, J. E., Fixsen, D. L., & Girardeau, F. L. (1969). Reinstatement of an operant response by the delivery of reinforcement during extinction. *Journal of Experimental Child Psychology*, *7*, 96-100. doi: 10.1016/0022-0965(69)90088-5

- Spradlin, J. E., Girardeau, F. L., & Hom, G. L. (1966). Stimulus properties of reinforcement during extinction of a free operant response. *Journal of Experimental Child Psychology, 4*, 369-380. doi: 10.1016/0022-0965(66)90038-5
- Sterling-Turner, H. E., Watson, T. S., Wildmon, M., Watkins, C. & Little, E. (2001). Investigating the relationship between training type and treatment integrity. *School Psychology Quarterly, 16*, 56-67.
- Stocker, S. (1998). Men and women in drug abuse treatment relapse at different rates and for different reasons. *NIDA Notes, 13*(4). Rockville, MD: National Institute on Drug Abuse.
- Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349-367. doi: 10.1901/jaba.1977.10-349
- Stokes, T. F., & Osnes, P. G. (1989). An operant pursuit of generalization. *Behavior Therapy, 20*, 337-355. doi: 10.1016/S0005-7894(89)80054-1
- St. Peter Pipkin, C., Vollmer, T. R., & Sloman, K. N. (2010). Effects of treatment integrity failures during differential reinforcement of alternative behaviour: A translational model. *Journal of Applied Behavior Analysis, 43*, 47-70. doi: 10.1901/jaba.2010.4347
- Strohmeier, C., Mulé, C., & Luiselli, J. K. (2014). Social validity assessment of training methods to improve treatment integrity of special education service providers. *Behavior Analysis in Practice, 7*, 15-20.
- Sweeney, M. M., & Shahan, T. A. (2013). Effects of high, low, and thinning rates of alternative reinforcement on response elimination and resurgence. *Journal of the Experimental Analysis of Behavior, 100*, 102-116. doi: 10.1002/jeab.26

- Todd, T. P., Winterbauer, N. E., & Bouton, M. E. (2012). Effects of the amount of acquisition and contextual generalization on the renewal of instrumental behavior after extinction. *Learning & Behavior, 40*, 145-157.
doi: 10.3758/s13420-011-0051-5
- Toogood, S. (2008). Interactive Training. *Journal of Intellectual and Developmental Disability, 33*, 215-224.
- Volkert, V. M., Lerman, D. C., Call, N. A., & Trosclair-Lasserre, N. (2009). An evaluation of resurgence during treatment with functional communication training. *Journal of Applied Behavior Analysis, 42*, 145-160. doi: 10.1901/jaba.2009.42-145
- Vollmer, T.R., Roane, H.S., Ringdahl, J.E., & Marcus, B.A. (1999). Evaluating treatment challenges with differential reinforcement of alternative behavior. *Journal of Applied Behavior Analysis, 32*, 9-23. doi: 10.1901/jaba.1999.32-9
- Wacker, D. P., Harding, J. W., Berg, W. K., Lee, J. F., Schieltz, K. M., ... Shahan, T. A. (2011). An evaluation of persistence of treatment effects during long-term treatment of destructive behavior. *Journal of the Experimental Analysis of Behavior, 96*, 261-282. doi: 10.1901/jeab.2011.96-261
- Welker, R. L. & McAuley, K. (1978). Reductions in resistance to extinction and spontaneous recovery as a function of changes in transportational and contextual stimuli. *Animal Learning & Behavior, 6*, 451-457.
- Whitworth, D., Harris, P., & Jones, R. (1999). Staff culture and the management of challenging behaviours in people with learning disabilities. *Mental Health and Learning Disabilities Care, 2*, 376-378.
- Winterbauer, N. E., & Bouton, M. E. (2010). Mechanisms of resurgence of an extinguished instrumental behavior. *Journal of Experimental Psychology: Animal Behavior Processes, 36*, 343-353. doi: 10.1037/a0017365

- Winterbauer, N. E., & Bouton, M. E. (2011). Mechanisms of resurgence II: Response-contingent reinforcers can reinstate a second extinguished behavior. *Learning and Motivation, 42*, 154-164. doi: 10.1016/j.lmot.2011.01.002
- Winterbauer, N. E., & Bouton, M. E. (2012). Effects of thinning the rate at which the alternative behaviour is reinforced on resurgence of an extinguished instrumental response. *Journal of Experimental Psychology: Animal Behavior Processes, 38*, 279-291. doi: 10.1037/a0028853
- Zanolli, K., & Daggett, J. (1998). The effects of reinforcement rate on the spontaneous social initiations of socially withdrawn preschoolers. *Journal of Applied Behavior Analysis, 31*, 117-125.
- Zlebnik, N.E., Anker, J.J., Gliddon, L.A., & Carroll, M.E. (2010). Reduction of extinction and reinstatement of cocaine seeking by wheel running in female rats. *Psychopharmacology, 209*, 113-125. doi: 10.1007/s00213-010-1776-0
- Zironi, I., Burattini, C., Aicardi, G., & Janak, P. H. (2006). Context is a trigger for relapse to alcohol. *Behavioural Brain Research, 167*, 150-155. doi: 10.1016/j.bbr.2005.09.007