12-1-2006

Contingency management techniques and smoking cessation in college students

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CONTINGENCY MANAGEMENT TECHNIQUES AND SMOKING CESSATION IN COLLEGE STUDENTS

by
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A Thesis

Submitted for partial fulfillment of the requirements of the
Master of Arts Degree
of
The Graduate School
at
Rowan University
October 31, 2006

Approved by
Advisor

Date Approved 12/1/06

ABSTRACT

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CONTINGENCY MANAGEMENT TECHNIQUES AND SMOKING CESSATION IN COLLEGE STUDENTS

2005/06

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The purpose of this study was to examine smoking cessation using different criteria for delivery of monetary reinforcement for college students from Rowan University, Glassboro, NJ. Participants participated in a 4 week study using a single subject reversal design (ABAC) in which baseline phases were alternated with either fixed criterion or shaping using an escalating schedule of reinforcement. The order of administration of intervention phases was determined randomly. Each intervention phase lasted 5 days (Monday-Friday). Results showed that contingent reinforcement for reduced carbon monoxide levels was effective in reducing smoking. However, additional studies need to be completed for longer periods of time.

ACKNOWLEDGEMENT

I would like to acknowledge my husband Ron, for standing by me through my entire graduate school process. Without him, I would not have made it as far as I have. He is my rock and anchor. I want to acknowledge my fellow students and colleagues for the numerous phone calls, rant sessions and unwavering support. Lastly, I want to acknowledge and thank my thesis advisor Dr. Kerwin, who put up with my many revisions, guided me through this process and showed continual support.

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CHAPTER 1

INTRODUCTION

Tobacco use is the single most preventable cause of death and disease, causing approximately 440,000 deaths annually in the United States (Center for Disease Control [CDC], 2002). Smoking is a major risk factor for cancer, heart and lung disease (CDC, 2001) and The National Cancer Institute (1999) reports that smoking results in an annual cost of more than $75 billion in direct medical costs. Scientists estimate that environmental tobacco smoke (ETS), also called "secondhand smoke," is responsible for approximately 3,000 lung cancer deaths per year among adult nonsmokers in the United States. Many people experience decreased quality of life due to the adverse health consequences of tobacco use (CDC, 2002).

These adverse health consequences are even more alarming in light of the number of youth who begin smoking regardless of the known risks of smoking. In 2002, 30 percent of the U.S. population 12 and older, about 71.5 million people, reported using tobacco at least once in the month prior to being interviewed (University of Rhode Island, 2001). This equates to an estimated 3.8 million people 12 to 17 years old, 14.0 million people 18 to 25 years old, and 53.7 million people 26 and older who use tobacco at least once in the last month. Approximately 80% of adult smokers start smoking before the age of 18. Every day, nearly 4,000 young people under the age of 18 try their first cigarette (National Cancer Institute, 2005). At the present time, it is estimated that

there are approximately 11 million smokers between the ages of 19 and 25 in the US (Substance Abuse and Mental Health Services Administration, 2001).

Although the CDC (2001) reports that the number of individuals aged 18-24 years who smoke has declined to its lowest level since 1991, this subset of the US adult population is still the largest population of individuals smoking today. Twenty-eight percent of college students began to smoking regularly at or after the age of 19, when most were already in college (Wechsler et al., 1998). The average age college students said they tried their first cigarette was 14 years (CDC, 2001).

Although data from 2003 implies a decrease in smoking among college students and young adults not in school, these trends remain quite disturbing. Despite the greater prevalence of smoking among non-college young adults, the relative increase in smoking was much greater among college students (CDC, 2003). Between 1990 and 1999, the 30-day prevalence of daily smoking increased by approximately 25% for non-college young adults, yet by almost 60% for full time college students (Johnston, O'Malley, & Bachman, 2003). These data indicate that smoking cessation interventions targeted specifically to college students should be developed. Despite the obvious benefits of not smoking, quitting smoking is hard. Researchers have used both behavioral and pharmacological treatments to help aid smoking cessation. Health professionals have used nicotine replacement therapy (NRT) products to help break the physiological addiction to nicotine (Fiore et al., 2000). Such products include smoking patches, gum, nasal spray, inhalers, smoke free cigarettes and medications such as Zyban® (Foulds et. al., 1992; GlaxoSmithKline, 2005; Groghan et al., 1998; Lamb et al., 2004; Schneider et al., 1996; Tiffany, Cox & Elash, 1999). In 1996, the U.S. Food and Drug Administration

(FDA) made nicotine patches and nicotine gum available over the counter in an effort to increase the access to these products. While each of these products has helped individuals in their attempts for smoking cessation, the success rates are low (Schneider et al., 1996).

Research shows that combining nicotine patches with another product (e.g. nicotine gum or nicotine inhaler) may improve abstinence from smoking compared to just using the nicotine patch alone (Bohadana, Nilsson, Rasmussen, & Martinet, 2000; Fagerstrom, Schneider & Lunell, 1993; Silagy, Lancaster, Stead, & Stapleton, 1999). Sweeney et al. (2001) suggest that more aggressive nicotine dosing may be necessary to improve smoking abstinence rates. Croghan et al. (2002) suggest a more rapid delivery of combining nasal spray with the patch may prove to have the most clinical effectiveness compared to other nicotine replacement therapies (NRT). The use of NRTs assumes that addressing the physiological addiction will result in a subsequent change in the psychological addictive behaviors. Although NRTs are somewhat effective, pharmacologic interventions alone are insufficient.

Contingency Management Interventions

One promising intervention for smoking cessation is contingency management (CM). CM is based on operant conditioning in which the probability of a person's response (i.e., smoking or not smoking) is partly determined by what follows the behavior (Skinner, 1960). If the consequence following a behavior results in an increase of the likelihood that the behavior will occur again in the future, the behavior is being reinforced. At its core, the contingency management approach to drug addiction is based on the idea that people use drugs because the drugs result in pleasure increasing the

probability of drug use in the future, thereby reinforcing drug use. As a result, the theory suggests that the way to counter this effect and to help people stop smoking is to provide sufficient and powerful reinforcement for not smoking.

From the operant theoretical viewpoint, numerous researchers have hypothesized that by substituting a similar or more powerful reinforcer as an alternative to the reinforcing properties of the drug, drug users may choose the alternative reinforcer to drug use and reduce or even quit their drug-taking activity (Corby, Roll, Ledgerwood, & Schuster, 2000). Maxine Stitzer from Johns Hopkins University was the first researcher to test the effectiveness of CM interventions for drug addiction (Stitzer, 1970). Dr. Stitzer began by making access to take home doses of methadone dependent upon drug-free urine samples in opiate addicted individuals.

Researchers have used several types of rewards or incentives to reduce drug use. These reinforcers may take a variety of different forms such as vouchers redeemable for a product or services; clinic privileges; free memberships; refunds of payments for programs; bonuses for behaviors; and other tangible material rewards (Heil, Alessi, Lussier, Badger & Higgins, 2004; Roll, Reilly, & Johanson, 2000; Roll et al., 1988; Stitzer, & Bigelow, 1983; Tidey, O'Neill, & Higgins 2002). The most commonly used reward is some sort of monetary incentives received immediately upon meeting the criteria set forth (Heil et al., 2004; Roll et al., 1988, 2000; Stitzer, & Bigelow, 1983; Tidey et al., 2002).

From the substance abuse literature, alternative contingent reinforcers seem most successful if they have several additional characteristics (Higgins et al., 1991). Contingent rewards are often cumulatively increased in value, using an escalating

schedule for abstinence. Each successive drug-free sample results in an increased amount of reward. If the client submits a sample positive for drugs, the reward schedule is reset to the initial lowest value. The client can earn the opportunity to return to the previous level after submitting several consecutive drug-free samples. In addition to the escalating schedule of reinforcement, researchers often provide participants with a bonus as well. For example a client submitting three drug free samples in one week may receive an added bonus. Offering bonuses for milestones achieved may increase the likelihood that the individual will continue to be abstinent by reinforcing continuous abstinence. The escalating schedule of reinforcement with bonuses, is perhaps the most widely used schedule of reinforcement for drug abstinence (Alessi, Baeger, & Higgins, 2004; Burling, Stitzer, & Bigelow, 1982; Dallery & Glenn, 2005; Gilbert, Crauthers, Mooney, McClernon & Jensen, 1999; Heil et al., 2004; Lamb, Morral, Galbicka, & Kirby, 2005; Roll, Higgins, Steingard & McGinley, 1988; Schroder, Gupman, Epstein, Umbricht & Preston 2003; Stitzer, Rand, Bigelow, & Mead, 1988; Tidey, O'Neill, & Higgins, 2002).

A preponderance of studies demonstrating the effectiveness of voucher based CM procedures have targeted single drugs, including alcohol (Petry, Martin, Cooney & Kranzler, 2000), marijuana (Budney, Higgins, Radonovich & Novy, 2000), opiates (Silverman et al., 1996) and cocaine (Higgins, Badger & Budney, 2000; Higgins et al., 1993, 1994; Silverman, Chutuape, Bigelow & Stitzer, 1999; Silverman et al., 1998; Silverman et al., 1996). For the purposes of this study we will concentrate on smoking (Lamb et al., 2004; Shoptaw et al., 2002).

Contingency Management Interventions for Smoking

Some of the earliest contingency management studies in smoking used either an escalating schedule of reinforcement or a fixed schedule of reinforcement (i.e., the amount of payment for each sample verifying no smoking remains constant over time). In one of the earliest studies to use CM with smokers, Burling, Stitzer, Bigelow and Russ (1982) utilized a variation of an escalating schedule of reinforcement for exhaling CO levels of 19-21ppm or 4-6ppm. The 24 participants rated 50 situations in which they completed a Likert scale rating their desire to smoke. Participants were also asked at the end of the study to describe what they had done to reduce their CO levels during the day. Participants who ate more food and drank more liquids abstained from smoking at a higher rate ($p<.01$) and earned more money than those who did not ($p<.05$). This study represents one of the initial studies demonstrating that access to alternative preferred events may increase rates of non-smoking among smokers.

In a study with 60 participants randomly assigned to four different amounts of payment contingent on smoking abstinence ($0, 1, 5, & 10), the $0 per day group reduced their CO by approximately 5ppm during the 2-week time period which was significantly different from the $5 and the $10 group (Stitzer & Bigelow, 1983). Their daytime cigarettes decreased in a systematic manner as the amount of payment available for CO reduction increased ($p<.001$). The $0 group degreased their average daytime cigarettes by 3.7 per day. The subjects offered $1, $5, & $10 per day decreased their daytime cigarettes by 5.5, 6.2, and 8.1 (Stitzer & Bigelow, 1983).

While Stitzer and her colleagues demonstrated that monetary rewards were more effective than no monetary rewards in reducing smoking, some researchers wondered if

the monetary payment needed to be contingent on nonsmoking or not. Alessi et al. (2004) investigated this question by comparing the typical escalating schedule of reinforcement for breath sample CO levels less than 4ppm against a control group that was yoked to the treatment group. Results indicated that the group receiving the reinforcement contingent on a CO level was more abstinent that the group receiving the non-contingent reinforcement. Of the sample, 59% of participants in the control group (noncontingent payment) sustained abstinence for the entire 12 day testing period compared to 41% of participants in the contingent payment group. This finding that monetary payments need to be contingent on reduced CO levels was replicated in another sample of 40 participants (Heil et al., 2004).

In a feasibility study with individuals with schizophrenia who smoked, Roll, Higgins, Steingard and McGinley (1998) utilized an ABA single-subject withdrawal design to compare an escalating schedule of reinforcement (B condition) to baseline conditions (A conditions) for 11 participants. Regardless of condition, participants were paid $5.00 each time they submitted a breath sample three times/day. Results indicated a significant decrease in exhaled CO level under contingency management condition (mean CO = 15.9 ppm) compared to baseline conditions (mean CO = 25.9 and 25.9 ppm, respectively).

Several studies have provided further evidence that some variation of an escalating schedule of reinforcement reduces smoking (Corby et al., 2000; Lamb et al., 2005; Stitzer & Bigelow, 1983; Stitzer et al., 1988). In a study investigating the added benefit of nicotine patch to an escalating schedule of reinforcement, Tidey, O'Neill, and Higgins (2002) randomly assigned participants to one of three experimental conditions:

CM combined with a Nicoderm ® 21mg/24hr patch, CM combined with a placebo patch, and a non-contingent monetary reinforcement with a placebo patch. Although smoking decreased during the contingent reinforcement condition, the nicotine patch did not enhance this effect.

A recent study has investigated different schedules of reinforcement for smoking abstinence in 20 volunteer adults not seeking treatment for smoking (Roll & Higgins, 2000). The three schedules of reinforcement were: a fixed magnitude of reinforcement for smoking abstinence, the escalating schedule of reinforcement with a reset and the escalating schedule of reinforcement without a reset. Using single subject designs, 18 smokers experienced all three schedules of reinforced in a counterbalanced order across participants. Each schedule of reinforcement was in effect for 5 days (Monday through Friday). The escalating schedule of reinforcement with a reset was more effective than the other two schedules in sustaining an initial period of abstinence. Based on the results of this study, the escalating schedule of reinforcement with reset appears to be the most efficacious schedule of reinforcement in reducing smoking. As a result, this escalating schedule of reinforcement with reset will be the schedule of reinforcement for smoking abstinence used in this study.

While an escalating schedule of reinforcement with reset appears to be the best schedule of reinforcement, it is unclear how to effectively implement this schedule for smoking behavior. Obviously, participants must submit a CO sample below a specified level for the contingency to be earned; however, how this level is specified has varied across studies. The research literature suggests that there are two methods of specifying the response. One method involves arbitrarily choosing a level of abstinence (e.g., CO <

8 ppm) and providing reinforcement only when the individual submits a sample meeting this fixed criterion. In contrast, another way of specifying the criterion is akin to shaping; setting the initial level at a level the individual is currently exhaling and then gradually and systematically decreasing the criterion CO level from session to session. While the majority of contingency management intervention studies with smoking have utilized a fixed criterion, several studies have investigated the effect of shaping on smoking abstinence.

The first study investigating shaping in smokers was conducted by Stitzer and Bigelow (1982). In this study, the criterion used during the contingency management intervention was 50% less than the average CO readings given by an individual in baseline. Stitzer et al. (1986) replicated the results of this study. Participants could receive $1 for a 30% reduction from the average baseline CO level and $6 for an 80% reduction. Participants received monetary compensation for attendance ($10 bonus) and for submitting a sample with a CO level less than 11 ppm ($4/sample). Results indicated that during the intervention phase, 96.5% of all the breath samples had a CO level less than 11 ppm and 80.5% of all breath samples had a CO level less than 8 ppm. Unfortunately, one study that attempted to replicate these findings using this methodology with smokers in a methadone maintenance program was unable to replicate these results (Schmitz, Rhoades, & Grabowski, 1995).

Lamb and his colleagues have refined this shaping methodology. In an initial study, Lamb, Morral, Kirby, Iguchi, and Galbicka (2004) evaluated the use of percentile schedules for determining the value for smoking abstinence. The authors examined the previous 10 samples given by the individual, and delivered incentives for breath COs at

or below the 10th, 30th, 50th, or 70th percentile of the recent 10 samples. Participants submitted a breath CO less than 4 ppm in more than 90% of the 30th, 50th and 70th percentile groups versus 63% in the 10th percentile group. In an extension of this study, Lamb, Morral, Galbicka, Kirby, and Iguchi (2005) used a single subject design to evaluate the time frame for determining the baseline average from which to calculate the first initial criterion. Lamb et al compared a four and nine session window for 71 smokers. In the four window condition, the CO levels needed to be lower than the 3rd lowest sample of the previous four samples. In the nine window condition, the CO levels needed to be lower than the 6th lowest sample of the previous nine samples. Results indicated that CO levels were lower in the condition in which the criterion was determined by four sessions compared to nine sessions (CO levels < 8.9 ppm and <12.5ppm, respectively); however, the differences between groups was not statistically significant.

In summary, research indicates that contingency management interventions are more effective than no intervention in decreasing the smoking of individuals in a variety of populations. Furthermore, the monetary reward needs to be delivered contingently on a behavior and the best schedule of reinforcement to use is an escalating schedule of reinforcement with a reset. In independent studies, the use of a fixed criterion seems to work as does successive decreases in criterion ala shaping. Thus far, however, no study has compared the use of fixed versus shaping criterion on smoking abstinence for the same individual. The purpose of this study is to determine if the effectiveness of contingency management for smoking cessation varies as a function of the criteria used to determine when vouchers are earned. One purpose of the present experiment was to

specifically study contingency management for cigarette smoking in a college population.

CHAPTER 2

METHOD

Participants

Participants were students at Rowan University who volunteered for a smoking reduction study. Participants were recruited via flyers posted around campus as well as flyers inserted into campus mailboxes. To be eligible for the study, students needed to be over the age of 18 years, report smoking 10 or more cigarettes/day for at least one year. In addition, students needed to answer negatively to the question, "Are you currently trying to or do you want to quit smoking?" and be dependent on nicotine as evidenced by a score of five or greater on the Fagerstrom Tolerance Questionnaire (Fagerstrom & Schneider, 1989). Exclusion criteria from this study include any medication that would influence smoking behavior, the use of nicotine gum, patches or any other smoking aid, those who can not come as often as needed, and those who are pregnant and/or breastfeeding, or a ppm score less than 15 ppm. Participants recruited were not informed of the inclusion criteria except for age limit. The participants signed an informed consent allowing researcher to use their CO readings and self reported measures as research.

Twenty-nine individuals were screened to determine if they were eligible for participation. Of these 29 students, 15 were eligible for the study. Those individuals who were ineligible for the study were too young (1), did not show up for the scheduled appointment (6), or did not meet the CO cutoff (6). Of the 15 eligible potential

participants, 9 provided informed consent; the remaining 6 were not able to commit to the four week study. Five females and four males, aged 19 to 22 years, were the subjects. Eight participants were Caucasian and one participant was of Cyprus decent. They smoked an average of 10 or more cigarettes a day and had an average CO level of 21.4 ppm.

Setting and Apparatus

Data collection occurred in a private, locked laboratory room on the Rowan University Campus. Individual CO samples were tested using the piCO Smokerlyzer® monitor (Bedfont Scientific). The piCO Smokerlyzer® uses disposable cardboard mouthpieces that connect to the monitor via a unique D-piece; breath passes through an innovative new infection control filter further reducing the risk of cross infection. Each research assistant was trained to monitor each participant CO sample. If a participant did not blow correctly into the piCO monitor, the participant was asked to re-submit their sample. The research assistants' closely monitored the machine for problems and identified if the machine needed to be re-calibrated or batteries needed to be replaced so to not give a false positive.

Experimental Design

The experimental design is a single subject withdrawal design (ABAC) in which each method of determining the behavioral criteria was in effect for five consecutive days. The study ran for 4 weeks.

Baseline. Baseline weeks occurred during weeks 1 and 3 during which participants were told to smoke in their normal fashion. During these baseline weeks,

participants reported to the laboratory on four separate occasions to submit their CO samples.

Criterion for CO Reduction. Intervention (either fixed or shaping method of determining criterion for reinforcement) occurred during Week 2 and 4. The two different conditions were delivered in counterbalanced order for each participant. Participants were randomly assigned to receive either the fixed behavioral criteria and/or the shaping criteria during Week 2 and vice versa on Week 4. During both conditions, the escalating schedule of reinforcement was implemented.

Fixed Criterion. In this condition, participants earned reinforcement (i.e., money) each time their CO reading was less than or equal to 4 ppm.

Shaping Criterion. In this condition, the criterion for earning reinforcement was determined by choosing the third highest CO value among the previous four samples given.

Measures

Participants were assessed at the initial baseline and at the end of each condition using the following three formal measures: Minnesota Nicotine Withdrawal Questionnaire, Tiffany Questionnaire on Smoking Urges, and the Smoking abstinence Self Efficacy Scale. In addition, participants were asked to recall their smoking frequency for the last 7 days (initial baseline) and the past week at the assessments occurring at the end of each condition.

Minnesota Nicotine Withdrawal Questionnaire (Hughes & Hatsukami, 1986) is a 8-item measure which includes the following: urge to smoke (craving); depressed mood; irritability, frustration, or anger; anxiety; difficulty concentrating; restlessness; increased

appetite; difficulty going to sleep; and difficulty staying asleep. Each item was rated by a subject on an ordinal scale from 0 (not at all) to 4 (severe). Mean withdrawal is derived as the average of the first seven items, with the desire-to-smoke item analyzed separately (Hughes & Hatsukami, 2000).

Tiffany Questionnaire of Smoking Urges (QSU; Tiffany & Drobes, 1991) is a 32-item questionnaire used to assess cravings for cigarettes. Confirmatory factor analysis results in a two factor solution of smoking craving. Factor 1 items reflect a strong desire and intention to smoke, with smoking perceived as rewarding for active smokers. Factor 2 items represent an anticipation of relief from negative affect with an urgent desire to smoke.

Smoking Abstinence Self-Efficacy Scale (SASE; DiClemente, 1991) is a 31-item measure of self-efficacy that includes ratings of both temptation (cue strength) and confidence (efficacy). The SASE consists of three subscales designed to assess confidence in not smoking in one of three situations: negative/affective situations characterized by conflict and distress, habit/addictive situations characterized by urges to smoke, and positive/social situations involving social activities and celebrations. Each subscale has demonstrated internal consistency (.88-.92) and the SASE has demonstrated acceptable construct validity.

Procedure

Flyers were posted around campus and placed in the mailboxes of students living on campus after permission was granted by the Office of Student Affaires. Interested students were screened for eligibility by phone. If the interested student met the self-report eligibility criteria for the study and was interested in participating in the study,

he/she was scheduled for an appointment at the laboratory with one of the research assistants. The research assistants were also students at Rowan University who were trained to criteria in study procedures by Dr. Kerwin.

At the appointment, the study procedures, risks, alternatives, and rights were explained to the eligible student. If the student provided informed consent for the study by signing the written informed consent document, he/she then completed the Fagerstrom Tolerance Questionnaire and submitted a breath sample by exhaling into the piCO Smokelyzer®. After holding his/her breath for 15 seconds, the participant was instructed to exhale for 20 seconds through the cardboard mouthpiece. The piCO meter measures the carbon monoxide level in the breath in particles per million (ppm); the level is shown within seconds on the unique colored LED display. Participants with a score of 15 or more on the Fagerstorm Tolerance Questionnaire and a CO level of 18 ppm or more were enrolled in the study.

If the student was enrolled in the study, they completed the MNWI (Hughes & Hatsukami, 1986), the QSU (Tiffany & Drobes, 1991) and the Self Efficacy measures (DiClemente, 1991). They were then scheduled for three more baseline appointments during the week. These appointments were scheduled at around the same time of day to control for environmental influences on smoking. At each of these four baseline sessions, the participant submitted a breath sample.

The participant was randomly assigned to an order of presentation of the two different conditions (fixed versus shaping). If the first assigned condition was the shaping condition, the research assistant determined the initial behavioral criterion level by finding the third highest CO level among the four immediate baseline levels. At the

final baseline appointment, the participant was provided with the instructions for the relevant condition.

Instructions for the Fixed Condition. "In order to achieve abstinence on Monday morning, you need to stop smoking Sunday afternoon at least 18 hours before the first test 1, but I can't give you an exact time to quit so you might want to stop sooner than that. Starting on Monday morning, you will receive money for CO readings less than or equal to 4 ppm. This will be your criterion for the next week. If your CO reading is less than or equal to 4 ppm, you will earn $3.00. If you keep meeting the cutoff, the payment will escalate by $.50. So your second consecutive sample meeting the criterion will result in a payment of $3.50. Each time you give two consecutive samples that meet criterion you will earn an additional $6.00. If you give CO samples that meet the criterion for the entire week, you could earn $82.50. However, every time you give a sample that doesn't meet the criterion or you don't have written documentation for skipping an appointment, you earn nothing and your payment schedule is reset to $3.00. If you give two consecutive samples that meet criterion, you can return to your previous level of earnings. If you can, please do not use any nicotine replacement products to help you achieve abstinence. Do you have any questions?"

Instructions for the Shaping Condition. "In order to achieve abstinence on Monday morning, you need to reduce your smoking this evening. Starting on Monday morning, you will receive money or gift certificates for CO readings less than or equal to XX ppm. If your CO reading is less than or equal to XX ppm, you will earn $3.00. The cutoff you are trying to achieve will change but if you keep meeting the cutoff, the payment escalated by $.50. So your second consecutive sample meeting the criterion will

result in a payment is $3.50. Each time you give two consecutive samples that meet criterion you will earn an additional $6.00. If you give CO samples that meet the criterion for the entire week, you could earn $82.50. However, every time you give a sample that doesn't meet the criterion or you don't have written documentation for skipping an appointment, you earn nothing and your payment schedule is reset to $3.00. If you give two consecutive samples that meet criterion, you can return to your previous level of earnings. If you can, please do not use any nicotine replacement products to help you achieve abstinence. Do you have any questions?"

If participants ask how to meet the specified criterion in this condition, they were advised that they will definitely meet the criterion if they stop smoking completely; however, they may still meet the criterion if they cut down on their smoking. After answering any of the participant's questions, the research assistant scheduled morning and afternoon appointments for each of 5 consecutive days in the next week (Monday through Friday). The participant was given a copy of the schedule as well as instructions for what to do if he/she could not make a scheduled appointment.

Schedule of Reinforcement. Depending on the level of CO in the breath sample during either the fixed or shaping condition, participants received a voucher, which could then be exchanged for money. If their CO sample meets their behavioral criterion, they received an initial monetary award of $3.00. For each successive sample that meets the specified criterion, the monetary value of the voucher was increased by $.50. If the participant submitted a CO sample above the specified criterion, he/she did not earn a voucher at that session and the value of the voucher was reset back to $3.00, from which escalation could again proceed according to the same schedule. Participants earned a

$6.00 bonus for each two consecutive samples submitted meeting the criterion specified. All money earned was paid in cash. Tables 1 and 2 illustrate the maximum amount of earnings and the possible earnings with a reset, respectively.

Table 1

Maximum Earnings with Escalating Schedule of Reinforcement

Day	Session	Voucher	Bonus	Total Earnings
Monday	1	$3.00		$3.00
	2	$3.50	$6.00	$9.50
Tuesday	3	$4.00		$4.00
	4	$4.50	$6.00	$10.50
Wednesday	5	$5.00		$5.00
	6	$5.50	$6.00	$11.50
Thursday	7	$6.00		$6.00
	8	$6.50	$6.00	$12.50
Friday	9	$7.00		$7.00
	10	$7.50	$6.00	$13.50
Total				$82.50

Table 2

Sample Earnings When Schedule of Reinforcement is Reset

Day	Session	Voucher	Bonus	Total Earnings
Monday	1	$3.00		$3.00
	2	$3.50	$6.00	$9.50
Tuesday	3	$0.00		$0.00
	4	$3.00		$3.00
Wednesday	5	$3.50	$6.00	$9.50
	6	$4.00		$4.00
Thursday	7	$0.00		$0.00
	8	$3.00		$3.00
Friday	9	$3.50	$6.00	$9.50
	10	$4.00		$4.00
Total				$45.50

At the final appointment during Weeks 2 and 4 (intervention weeks), participants completed again the MNWI (Hughes & Hatsukami, 1986), the QSU (Tiffany & Drobes, 1991) and the Self Efficacy measure (DiClemente, 1991). Participants were given the following instructions, "This weekend and next week, you can smoke as you usually do. I will schedule 4 appointments for you to come in and give a breath sample at each appointment. The final appointment will be on Friday pm. Do you have any questions?" Other researchers in the field have discovered that payment for completion is necessary

in the context of CM interventions; participants will often not return for sessions if they know that they have not met the criteria. In order to maximize the chance of obtaining complete data, participants completing the study were given a voucher for $75.

CHAPTER 3

RESULTS

Consistent with single subject reversal designs, data are presented for each individual. Appendix A shows Figure 1, which exhibits the CO level in ppm for each session as a function of baseline, fixed, and shaping methods of determining the criterion for reinforcement using an escalating schedule of reinforcement for Participant 1 (T1). Visual analysis of Figure 1 reveals that CO levels were lowest in the fixed condition. The mean CO level in Baseline 1 was 11.25. The mean CO level in the Fixed criteria treatment phase was 1.9 (7 data points). The mean CO level in baseline 2 was 9.25. The mean CO level in the Shaping criteria treatment phase was 5.0 (5 data points). T1 submitted completed the entire study. Although it appears that the Fixed condition was superior, it was determined later that the apparatus had been malfunctioning during that condition; therefore, the accuracy of the CO levels is suspect.

Figure 2 (Appendix B) presents the individual data for the second participant (T2). Shaping and fixed conditions appeared to decrease CO levels to an equivalent level. The mean CO level in Baseline 1 was 19.5. The mean CO level in the Shaping criteria treatment phase was 9.9 (9 data points). The mean CO level in baseline 2 was 20.0. The mean CO level in the Fixed criteria treatment phase was 11.22 (10 data points). T2 completed the entire study. There was one missed appointment due to miscommunication with the research assistant.

T3 (Appendix C) had more success with the shaping criteria (see Figure 3). During the fixed criterion condition, T3 did not meet any of the fixed criteria and CO levels were relatively high (53.6 over 7 samples). The mean CO level for baseline 1 was 31.25 and for baseline 2 was 36.25. The mean CO level for the Shaping criteria treatment phase was 33.2 (5 points). T3 completed the study.

Figure 4 (Appendix D) depicts the data for the fourth participant. Visual inspection of the data reveals that the fixed criterion appeared to result in lower CO levels compared to the shaping condition. The mean CO level for baseline 1 was 10.25. The mean CO level for the Fixed criterion treatment week was 3.0 (6 points). The mean CO level for baseline 2 was 8.25. It appears from visual inspection of Figure 4 that T4 may have reduced smoking in the initial part of the second baseline week but then resumed pre-research levels by the end of the phase. The mean CO level for the Shaping criteria treatment condition was 5.7 (10 points). T4 became sick during the last treatment week and was only able to submit 6 out of the 10 samples. However, T4 completed the study.

T5 (Appendix E) started into the baseline sampling at a later date than the other participants. Due to T5's early departure, the study was changed to accommodate T5's schedule. T5's baseline samples were taken within a two day time period, once in the AM and once in the PM, during the same time of day so to allow T5 to have four baseline samples, rather than taking the samples over a week's time. The mean CO level for baseline 1 was 10.0 (Figure 5). The mean CO level for the Shaping criteria treatment phase was 5.6 (9 points). The mean for baseline 2 was 10.0 (2 points). The mean CO

level for the Fixed criterion treatment phase was 2.0 (5 points). Unfortunately, T5 demonstrated a decreasing trend in CO levels during the second baseline phase. It is unclear, therefore, whether the relatively low CO levels observed in the Fixed condition were a function of the Fixed condition or the previous decreasing pattern in the baseline period preceding the condition. T5 completed the entire study.

Visual analysis of Figure 6 depicts the data for T6 (Appendix F). Although T6 began the study with integrity (i.e., completed the expectations for the first 2 weeks), T6 submitted only 2 samples in the second baseline phase and only one data point for the second treatment phase. Because T6 did not complete the study and because only one data point was submitted in one of the treatment phases, these data cannot be interpreted. The mean CO levels for the baseline phases were 33.75 and 19.5, respectively. Given these CO levels, it appears as though T6 had returned to preintervention levels of smoking. Although T6's data do not allow a comparison between condition, the mean CO level for the Fixed criteria treatment phase was 27.0 (1 points) compared to an average of 11.6 (8 points) in the shaping condition. T6 did not complete the entire study.

T7 (Appendix G) only completed the initial baseline and first treatment phase before dropping out of the study (Figure 7). The mean CO level for baseline 1 was 10.3 (3 points). The mean CO level for the Shaping criterion treatment phase was 4.5 (7 points). T7 did not complete the entire study.

T8 (Appendix H) only completed the initial baseline and first treatment phase before dropping out of the study (Figure 8). The mean CO level for baseline 1 was 14 (3 points) and the mean CO level for the Fixed criteria treatment phase was 12.7 (6 points).

Visual inspection of Figure 8 reveals that the fixed condition did not function to reduce smoking for T8. T8 did not complete the entire study.

T9 had more success with the shaping criteria and met every criterion set forth. However after the first treatment phase, T9 missed several appointments during the second treatment phase (Figure 9; Appendix I). The mean CO level for baseline 1 was 15. The mean CO level for the Shaping criteria treatment phase was 2.56 (9 points). The mean CO level for baseline 2 was 14.0. The mean CO level for the Fixed criterion treatment phase was 16.67 (3 points). It appears that T9 resumed smoking throughout both baseline phases. T9 completed the entire study.

To allow easy comparison across individual participants, Table 3 depicts the mean CO levels for each participant in each phase. In addition, the presentation of the first condition is indicated by graying out the block of the table.

Table 3

Mean CO Levels (Number of Sessions) by Condition for Each Participant

	Condition			
Participant	Baseline 1	Fixed	Baseline 2	Shaping
T1	11.25 (4)	1.9 (7)	9.25 (4)	5.00 (5)
T2	19.5 (4)	9.9 (10)	20.00 (4)	11.22 (9)
T3	31.25 (4)	53.57 (7)	36.25 (4)	33.2 (5)
T4	10.25 (4)	3.00 (5)	8.25 (4)	1.50 (10)
T5	10.00 (4)	5.6 (10)	10.00 (2)	2.0 (5)
T6	33.75 (4)	10.37 (8)	19.50 (2)	27.00 (1)
T7	7.00 (3)			4.50 (6)
T8	14 (3)	12.7 (6)		
T9	15 (4)	16.67 (3)	14.00 (4)	2.56 (9)

Note: Blanks in the table indicate that the participant did not complete the criteria needed nor finished the study.

CHAPTER 4

DISCUSSION

The hypothesis that was presented in this study was to reduce smoking in college students by providing monetary reinforcement for CO levels produced through not smoking. The present study provides preliminary data comparing fixed criteria versus shaping criteria in a contingency management intervention with the same participant using an escalating schedule of reinforcement. Although previous research has studied either a fixed criterion or shaping criterion, we are aware of no studies that have investigated both at the same time with the same participants. Providing monetary reinforcement for the reduction of CO levels replicates studies performed by Corby, Roll, Ledgerwood, and Schuster (2000), Heil et al. (2004), Roll et al. (1988, 2000), Stitzer, & Bigelow (1983), and Tidey et al. (2002).

The present study utilized chronic smokers to participate in a four week study to determine the efficacy of a procedure with potential treatment application. The study has shown that contingent reinforcement for reduced carbon monoxide levels was clearly effective in promoting reducing smoking while in the treatment phase, as seen in both objective and self reported measures.

The present study also showed an orderly relationship between pay amount and the extent of behavior change observed. Participant 6 and 9 successfully met the criteria for their first treatment phase. With the exception of Participant 3, all participants

generally reduced their smoking more than necessary to meet reinforcement criteria. The lasting changes noted in baseline smoking measures after their initial contingent reinforcement intervention was removed were small and clinically insignificant. The CO levels were as high if not higher during the second baseline measure with the exception of participant 4 & 6.

A potentially important feature of the contingent payment procedure used in the present study is that it allows the participants to remain in their everyday environments, possibly producing more vigorous and generalizable results. In addition to being a potentially clinically effective intervention, contingency management techniques may be highly cost effective. The total amount that could have potentially been earned by each participant was $240.

Of the nine participants, seven participants came to at least one session in both intervention phases. Of the nine participants, five participants came to two sessions in both intervention phases. Of the nine participants, four participants had more success during the Shaping Intervention Phase. Three participants had more success with the Fixed Intervention Phase. Participant 5 steadily reduced their CO intake through the Shaping Intervention phase and maintained abstinence through the Fixed Intervention phase. Participant 3 had great difficulty with the Fixed Intervention Phase. By self-report, participant 3 was a chronic cannabis user and did not abstain throughout the study. Therefore, participant 3 met no criteria during this fixed stage. Participant 4 became sick after the second baseline sampling with a stomach virus which kept the participant from achieving further success within the Fixed Intervention stage.

Limitations

Some limitations with this current study were the availability of the research assistants, the complete training of the research assistants, schedule conflicts of participants' school schedule, limited sample size, inconsistent participant attendance, and miscommunication between participants and the research assistants. Other limitations were that there was no nontreatment control group; therefore it is difficult to say how much of these interventions increase positive outcomes over what would be expected to occur naturally. In addition, present results were collected with cigarette smokers and may not generalize to other types of drug use. Finally, our study sample was predominately white (88%) therefore determination by ethnicity was not present. Worth mentioning, is that it cannot be determined from this study whether the effects observed would be different if one used an alternative means for achieving abstinence. Another limitation is that there is no long term outcome data. Such data will be important in future studies to examine if the potential of these interventions such as this one would increase long-term smoking cessation.

Few intervention studies have been successfully conducted on college prevention programs so there is little information in the literature as to the effectiveness. Few cessation programs are available on college campuses, and the ones that are available have not been evaluated to measure their effectiveness. The current study did not test the effectiveness of an on campus smoking cessation program but tested the feasibility of using contingency management to reduce cigarette smoking among college students. The present study showed a relationship between pay amount and the behavior observed. The

efficacy of two different schedules of reinforcement for promoting and sustaining smoking abstinence was compared in this study.

Abstinence was significantly greater during the intervention condition than during the baseline conditions. These results illustrate the potential sensitivity of cigarette smoking in this population to reinforcement contingencies, suggesting that contingency-management interventions are a feasible option for treating smoking abuse of individuals Contingency-management interventions that provide reinforcement in the form of exchangeable vouchers for monies, contingent on drug abstinence, are among the most effective substance abuse treatment strategies available. Factors known to contribute to the efficacy of these interventions include voucher magnitude and the schedule with which vouchers are made available. These results of this study suggest that cigarette smoking among college students is responsive to contingency management procedures.

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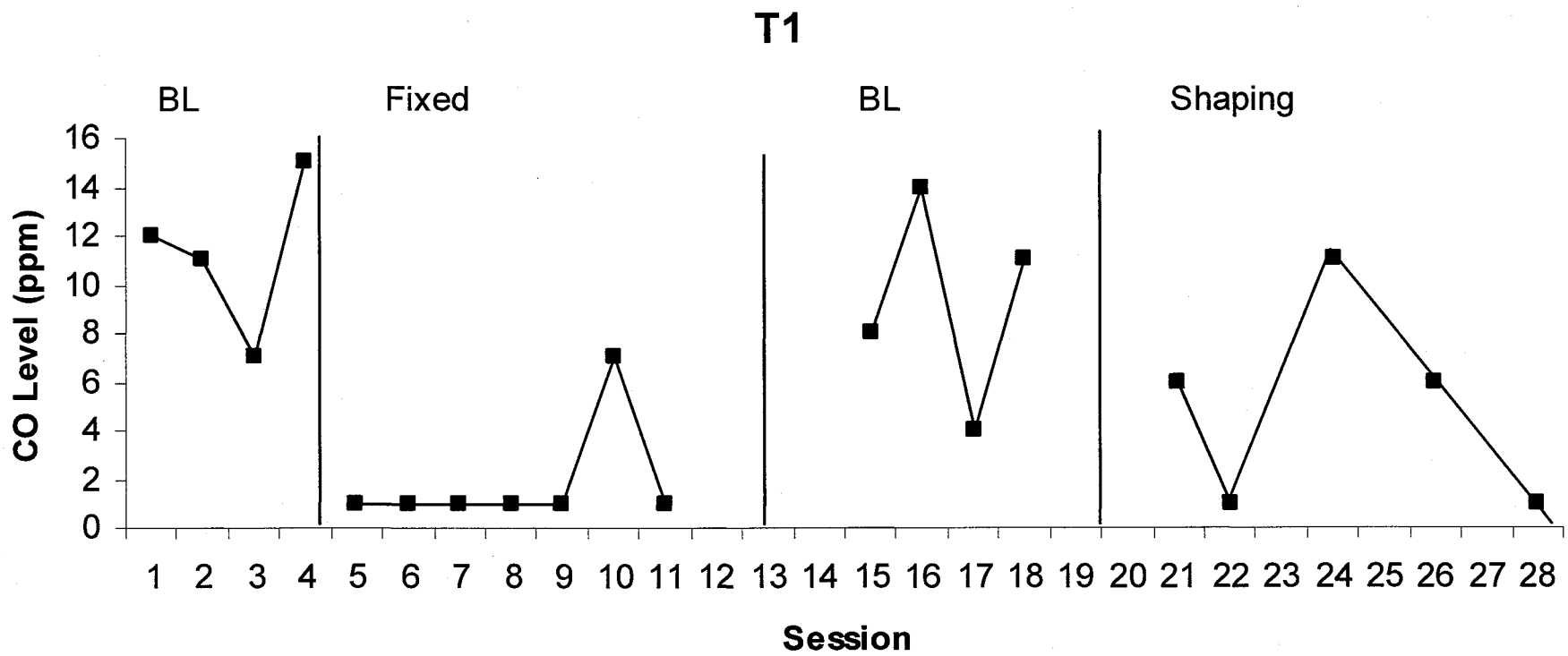
APPENDICES

APPENDIX A

Figure 1: Graph of T1 Data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Fixed
BL
Shaping
CO Level (ppm)
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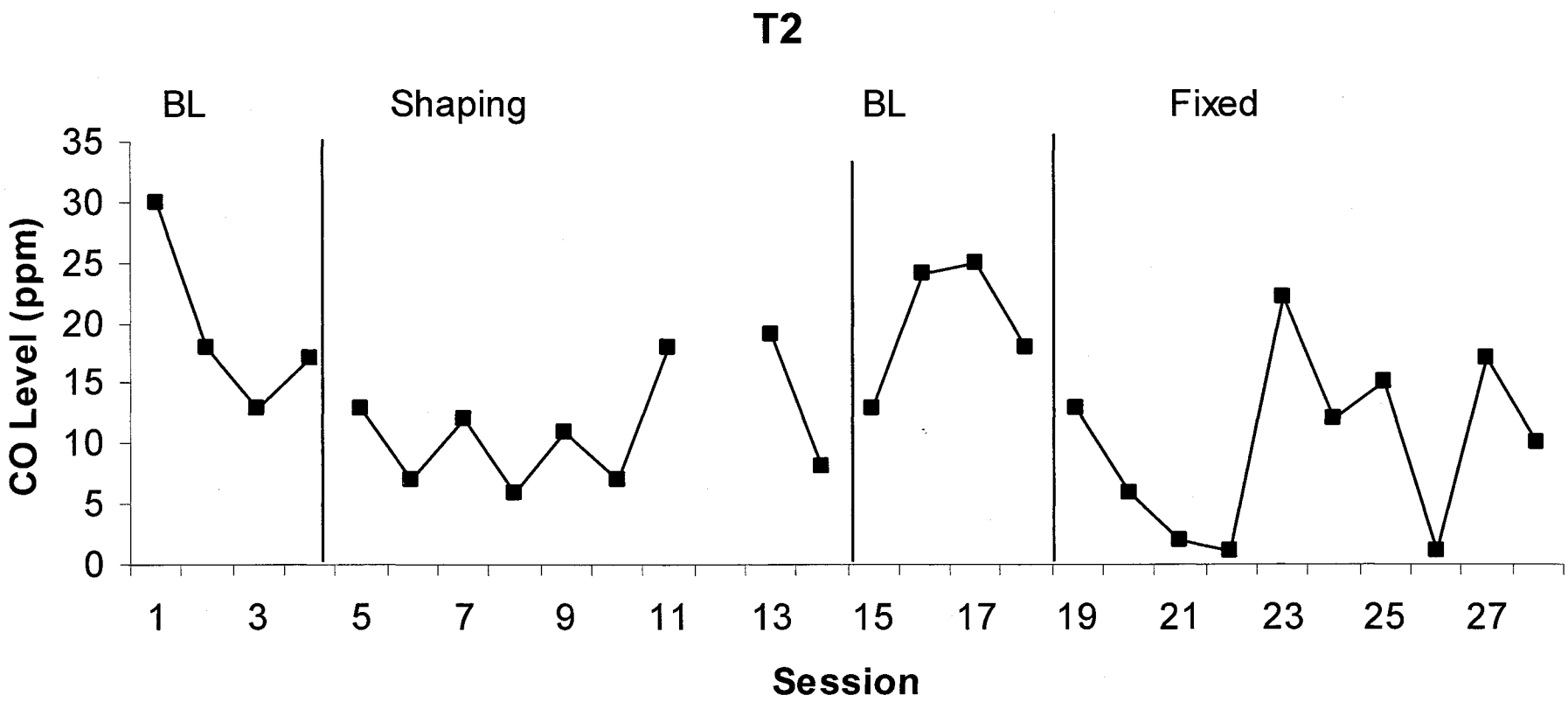
2
4
6
8
10
12
14
16
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Session

APPENDIX B

Figure 2: Graph of T2 Data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Shaping
BL
Fixed
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30
25
20
15
10
5
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1
3
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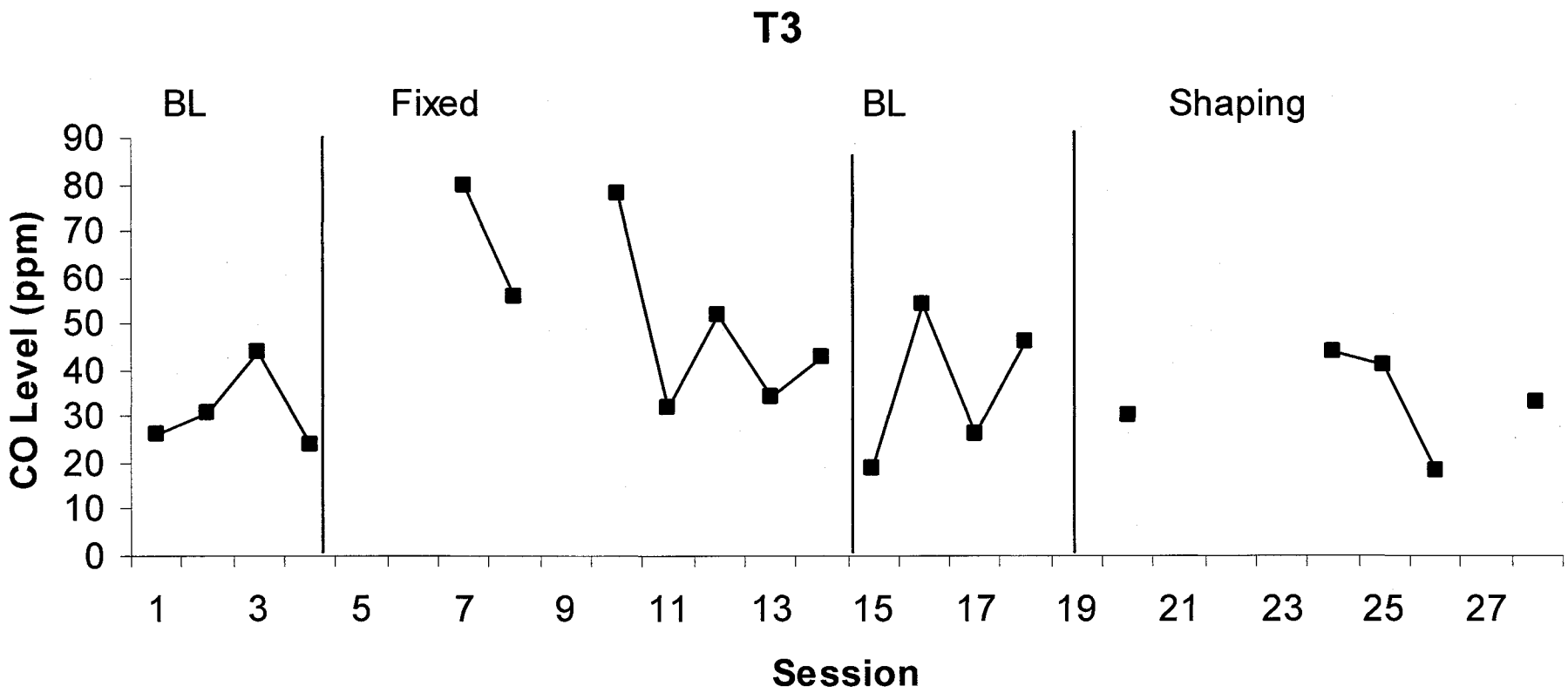
7
9
11
13
15
17
19
21
23
25
27
Session

APPENDIX C

Figure 3: Graph of T3 Data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Fixed
BL
Shaping
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30
20
10
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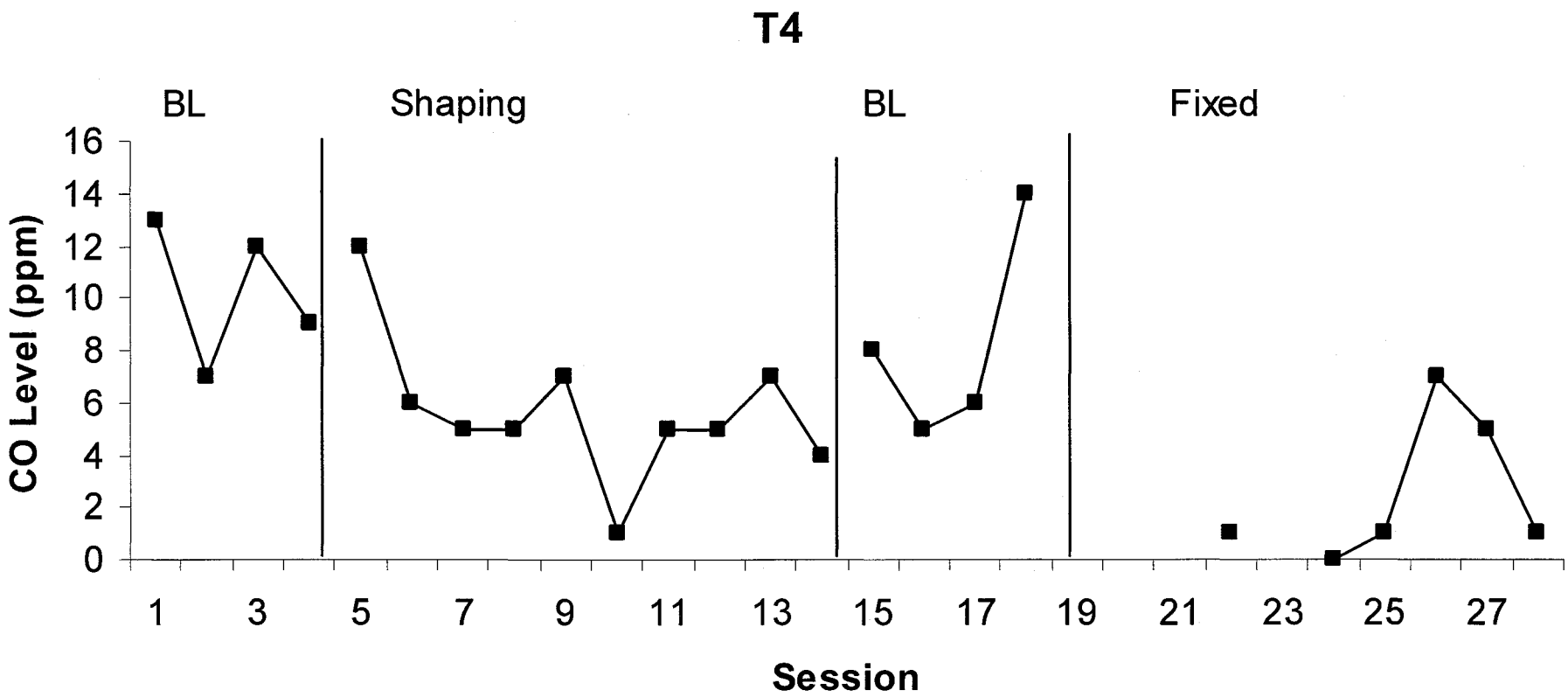
7
9
11
13
15
17
19
21
23
25
27
Session

APPENDIX D

Figure 4: Graph of T4 Data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Shaping
BL
Fixed
CO Level (ppm)
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12
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8
6
4
2
0
1
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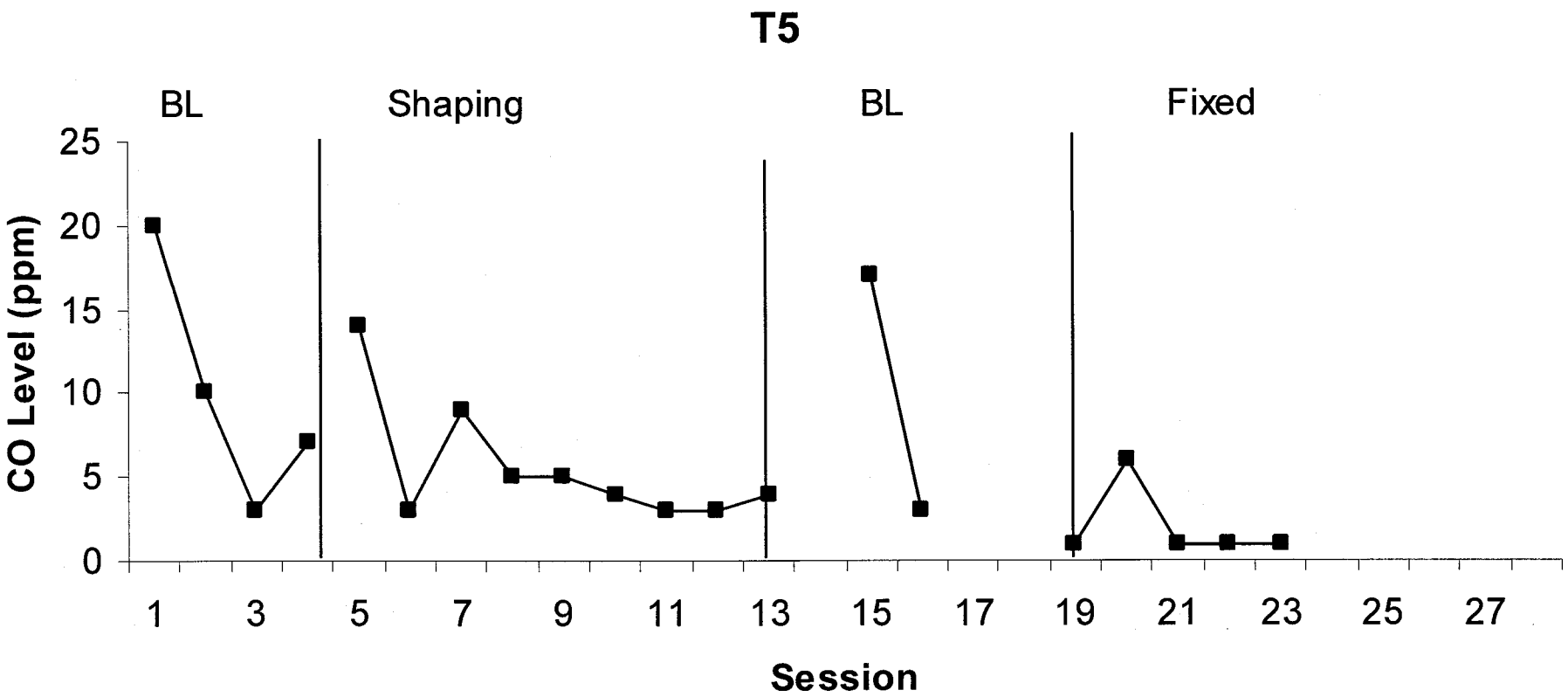
9
11
13
15
17
19
21
23
25
27
Session

APPENDIX E

Figure 5: Graph of T5 Data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Shaping
BL
Fixed
CO Level (ppm)
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15
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5
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1
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9
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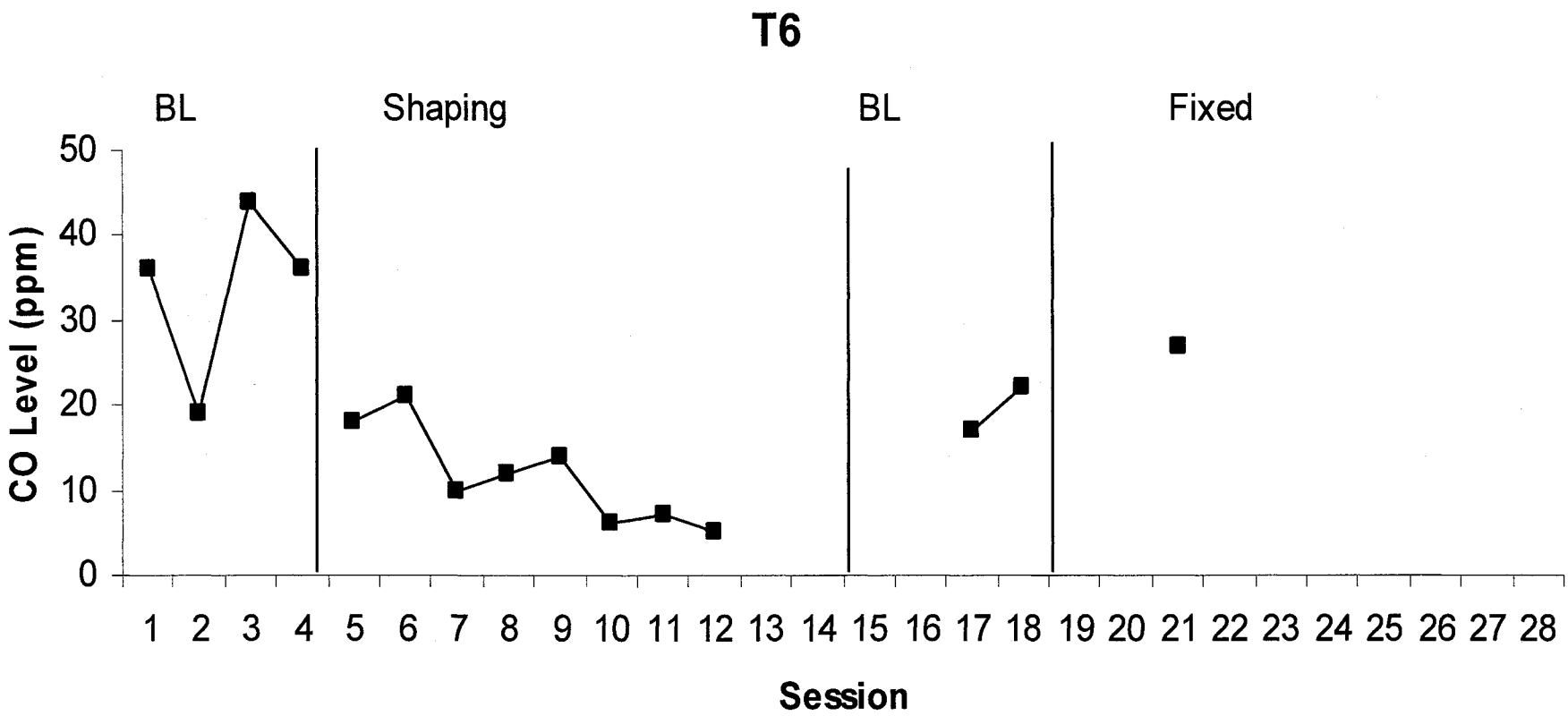
13
15
17
19
21
23
25
27
Session

APPENDIX F

Figure 6: Graph of T6 Data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Shaping
BL
Fixed
CO Level (ppm)
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30
40
50
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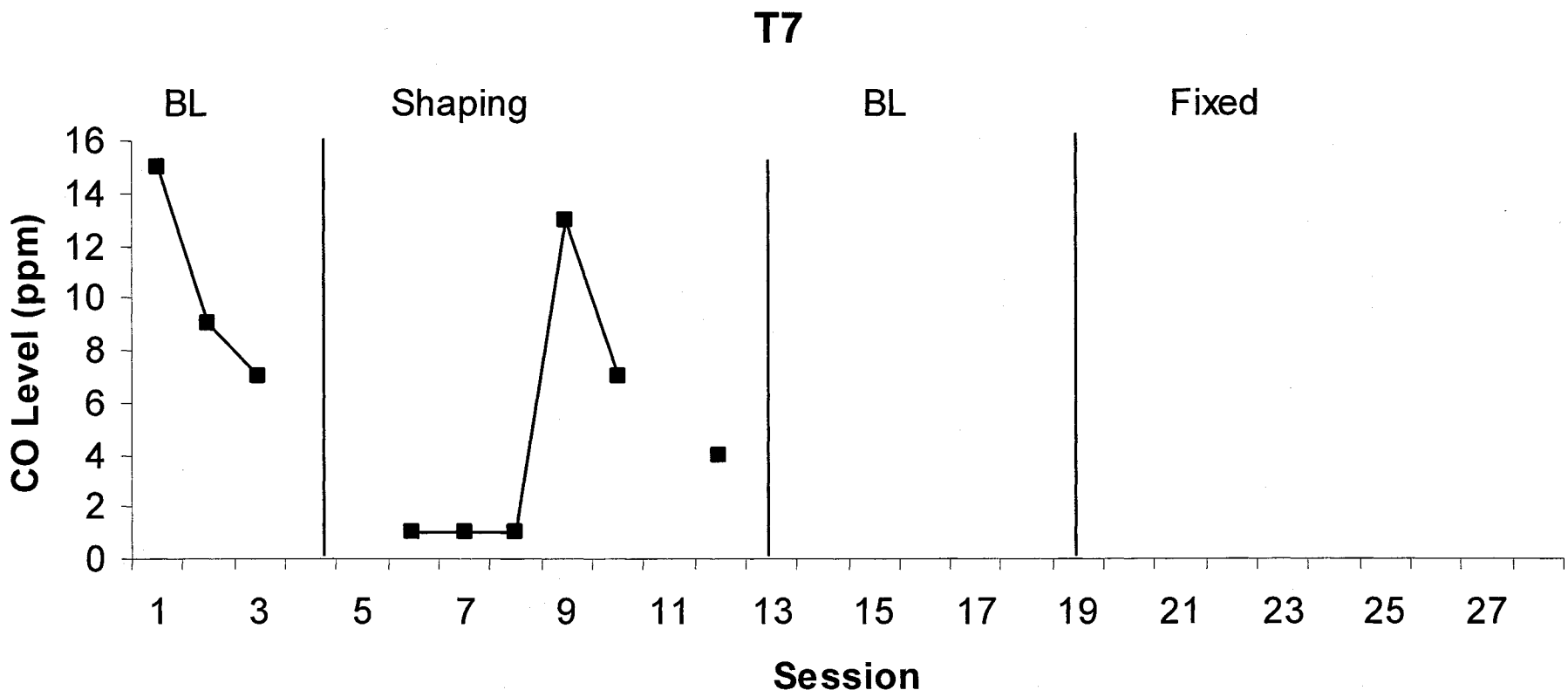
Session

APPENDIX G

Figure 7: Graph of T7 Data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Shaping
BL
Fixed
CO Level (ppm)
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14
12
10
8
6
4
2
0
1
3
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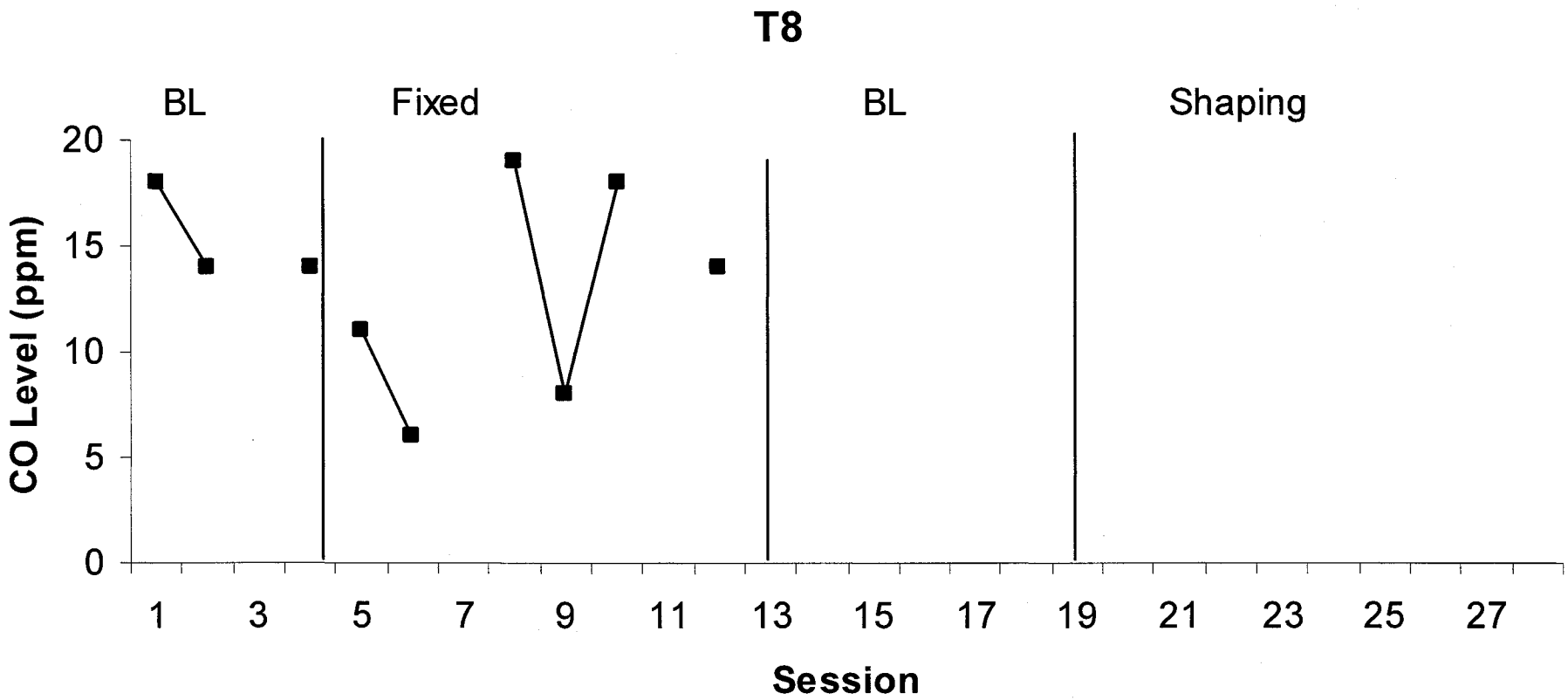
7
9
11
13
15
17
19
21
23
25
27
Session

APPENDIX H

Figure 8: Graph of T8 Data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Fixed
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Shaping
CO Level (ppm)
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10
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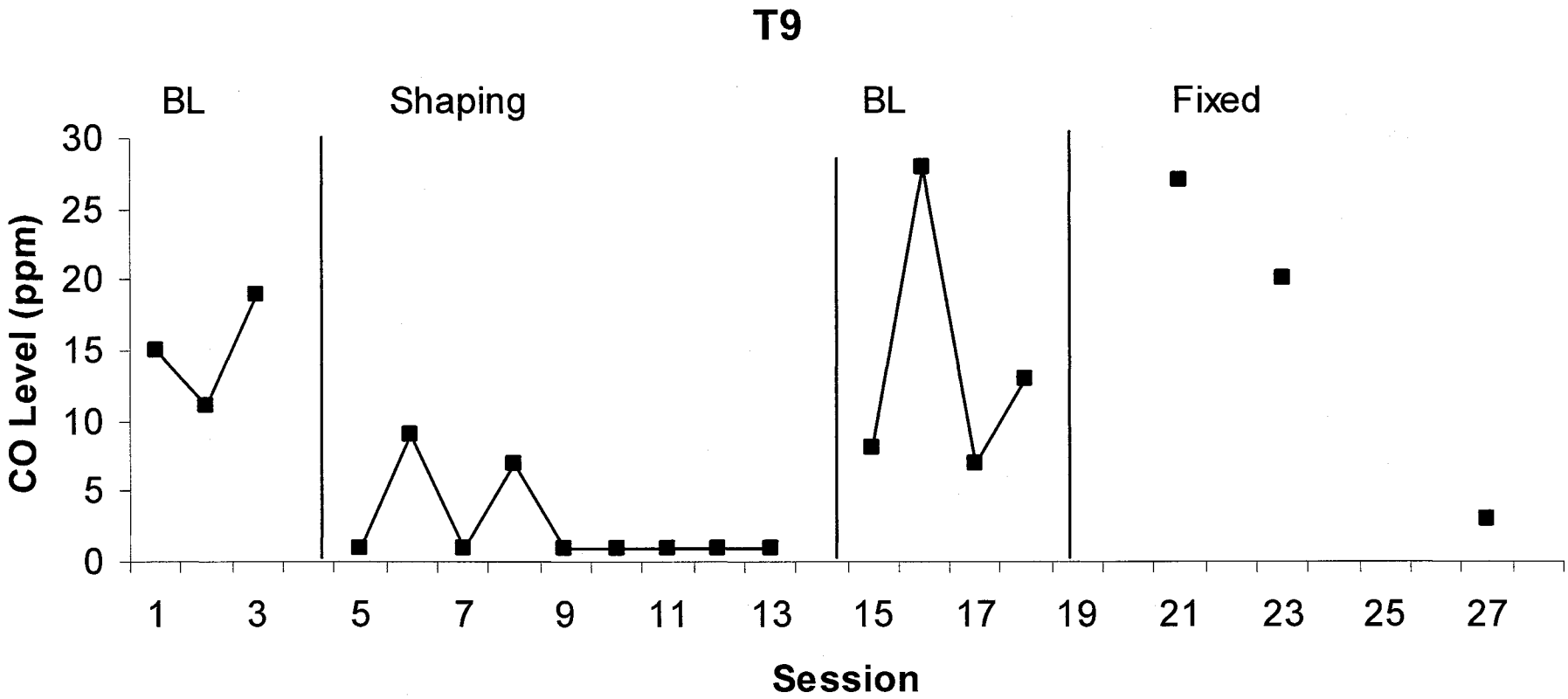
9
11
13
15
17
19
21
23
25
27
Session

APPENDIX I

Figure 9: Graph of T9 Data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Shaping
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1
3
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7
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11
13
15
17
19
21
23
25
27
Session