Behavioral covariation in the treatment of chronic pain
by Michael John Kalsher

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in
Psychology

Montana State University

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Abstract:

The successful use of operant procedures to alter behaviors associated with various medical conditions suggests that such behaviors may be learned and that the principles of learning may be applied not only to treatment but also to the study of the pathogenesis of illness behavior. The present study, conducted within an ongoing neuromuscular research project, assessed the covariation of behaviors associated with chronic pain within and across behavioral and drug approaches to treatment. Problems of screaming and five other behaviors (including self-reports of pain) were measured across conditions of varying behavioral contingencies (noncontingent reinforcement vs the removal of reinforcement contingent upon screaming) and drug administration (time since medication and dosage) of Parsidol during attempts to treat the muscle pain of a 24-year-old male with a severe, chronic neuromuscular disorder diagnosed as dystonia musculorum deformans (DMD). Results indicated that: (a) pain behaviors covaried during behavioral and drug conditions even though the behavioral intervention only targeted screaming; (b) effects were greater on nontargeted behaviors during periods that followed rather than preceded drug administration; (c) in contrast to behavioral observation data, physiological measures of neuromuscular activity (EMG) did not differ across conditions. These results suggest that functional response-response relationships exist in patients as the result of their illness experience.

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Abstract

The successful use of operant procedures to alter behaviors associated with various medical conditions suggests that such behaviors may be learned and that the principles of learning may be applied not only to treatment but also to the study of the pathogenesis of illness behavior. The present study, conducted within an ongoing neuromuscular research project, assessed the covariation of behaviors associated with chronic pain within and across behavioral and drug approaches to treatment. Problems of screaming and five other behaviors (including self-reports of pain) were measured across conditions of varying behavioral contingencies (noncontingent reinforcement vs the removal of reinforcement contingent upon screaming) and drug administration (time since medication and dosage) of Parsidol during attempts to treat the muscle pain of a 24-year-old male with a severe, chronic neuromuscular disorder diagnosed as dystonia musculorum deformans (DMD). Results indicated that: (a) pain behaviors covaried during behavioral and drug conditions even though the behavioral intervention only targeted screaming; (b) effects were greater on nontargeted behaviors during periods that followed rather than preceded drug administration; (c) in contrast to behavioral observation data, physiological measures of neuromuscular activity (EMG) did not differ across conditions. These results suggest that functional response-response relationships exist in patients as the result of their illness experience.

INTRODUCTION

Assessment and management of chronic pain are issues that have received increased attention in the behavioral literature (e.g., Fordyce, 1976). Although an operational definition of pain eludes precise medical description (Schmitt & Worden, 1980), the field of behavioral medicine has produced what appears to be a functional model. Presented by Katz and Zlutnik (1975), a behavioral definition for pain is comprised of two parts: (a) internal physiological components elicited by nociceptive stimuli and currently unable to be directly detected and (b) overt behavioral responses correlated with pain experience. The objective pain expression component allows for the demonstration of treatment effects in the absence of physiological or subjective pain report measures. Research on the assessment and management of chronic pain behaviors has extensively demonstrated that they are susceptible to modification by environmental events. These modifiers include operant procedures such as extinction, differential reinforcement of other behavior, and reinforcement of habilitative behaviors (Fordyce, Fowler, Lehmann, & DeLateur, 1968; Fordyce, Fowler, Lehmann, DeLateur, Sand, & Trieschmann, 1973; Sank & Biglan, 1974; Varni, Bessman,

Russo, & Cataldo, 1980).

A review of the pain literature by Chapman, Casey, Dubner, Foley, Gracely, and Reading (1985) critically examines more than 100 studies to identify recent progress in pain measurement technology. Their review includes studies from the areas of animal research, human subjects laboratory investigations, and clinical studies.

For laboratory studies of human subjects, Chapman et al. (1985) suggest that physiological correlates such as electromyography (EMG) be used in combination with subjective report measures. Although physiological measures can provide valuable information regarding the mechanisms underlying pain states, they may be subject to psychological variables such as expectancy or attention. Further, more work is needed to demonstrate which measures are best suited for a given situation.

Clinical assessment of pain has focused on the use of behavioral measures (particularly those methods employing direct observation) to identify pain states. For example, Keefe and his associates defined pain behaviors as guarding, bracing, grimacing, and sighing and have developed a direct observation system for assessing pain in patients with chronic back pain (Keefe, Wilkins, & Cook, 1984; Keefe & Block, 1982) and with head and neck cancer pain (Keefe, Brantley, Manuel, & Crisson, 1985). Additionally, Keefe, Wilkins, and Cook (1984) obtained interobserver agreement

exceeding 90%.

Cinciripini and Floreen (1982) introduced an observation procedure in which pain talk, non-verbal pain behavior, non-pain complaints, pro-health talk, and assertive behavior were systematically observed and recorded.

Bonnel and Boureau (1985) used a direct behavioral observation system in conjunction with patient self-report to assess labor pain in primiparous women. Their observation system consists of a 5-category intensity scale to score manifestations of pain defined as respiratory modification, motor responses (e.g., grasping), and agitation. Chapman et al. (1985) conclude that behavioral methods are particularly useful for assessing pain relief and treatment effects when adequate precision is employed in defining the behaviors under study.

Fordyce, Roberts, and Sternbach (1985) recently examined a number of reviews which focus on the results of behaviorally oriented treatment programs for chronic pain. Fordyce et al. (1985) observed that most of these programs found favorable outcomes. The programs reviewed were based on the assumption that audible and visible communication of pain, along with associated physical impairments are behaviors that may come under the control of conditioning effects. For example, several studies (Anderson, Cole, Gullickson, Hudgens, & Roberts, 1977; Fordyce, Fowler,

Lehmann, DeLateur, Sand, & Trieschmann, 1973; Fordyce, Lansky, Calsyn, Shelton, Stolov, & Rock, 1984; Roberts & Reinhardt, 1980) demonstrate the positive impact of social contingency influences on pain behavior since all reported significant decreases in the amount of medication used and increases in activity level. The potency of these interventions is strengthened when one considers that these methods are usually applied to individuals who have repeatedly failed to obtain pain relief from more traditional methods (e.g., surgery).

Since some behavioral procedures for the assessment and treatment of chronic pain are effective, others may also be relevant. In particular, variables related to a functional definition of response classes have proven clinically relevant in behavior therapy and may have applications in behavioral medicine. A response class has been defined as a group of responses which develop or change together, through a similar reinforcement history (Bijou & Baer, 1967; Millenson, 1971). A response class has been further characterized by demonstration of similarities in behavioral topography (Sajwaj, Twardosz, & Burke, 1972) or functional interdependence (Gewirtz, 1971) among members.

The clinical utility of response class considerations has been demonstrated in the treatment of oppositional behaviors (Neef, Shafer, Egel, Cataldo, & Parrish, 1983; Russo, Cataldo, & Cushing, 1981; Wahler, 1975; Wahler & Fox,

1980), enuresis (Nordquist, 1971), stuttering (Wahler, Sperling, Thomas, Teeter, & Luper, 1970), and sharing behavior (Barton & Ascione, 1979), to name just a few.

Response class considerations may be relevant to pain behaviors in a number of ways. While pain behaviors can vary in terms of modality of expression, frequency, intensity and duration, the similar effect that they have on the patient's environment (e.g., attention from others, PRN medication administration, avoidance of work) suggest that they can become an operant response class. Examination of pain behaviors as a response class may identify those behaviors most responsive to modification and thus facilitate treatment. For example, screaming, crying, and facial contortions may be members of a single response class so that intervention for any single behavior may produce changes in others.

This study represents an attempt to investigate chronic pain response class variables by studying behavioral covariation in a patient exhibiting a variety of pain behaviors. Specifically, the effects of reinforcement and the contingent removal of reinforcement on one selected pain behavior (i.e., screaming) were investigated in the context of a reversal design with a patient having dystonia musculorum deformans (DMD). DMD is a progressive, genetically determined neuromuscular disorder, characterized by strong, sustained twisting and writhing motions of the

somatic muscles, adduction of the thigh and continuous torsion spasms (Jabbour, Duenas, Gilmartin, & Gottlieb, 1976) associated with severe, chronic muscular pain (Zeman & Dyken, 1967). The specific mechanisms for such pain are as yet unknown, although possibilities include: (a) ionic depletion in which an imbalance exists between elements necessary for normal muscle action, such as sodium, calcium and potassium (Mountcastle, 1980; Sweet, 1975); (b) lactic acidosis in which lactic acid accumulates and results in oxygen debts in the same manner as during prolonged strenuous exercise (Selkhurt, 1976); (c) ischemia in which blood flow to muscle tissue is inadequate and results in oxygen deficiency (Lloyd, 1971; Mountcastle, 1980).

Despite this gap in knowledge, research has shown muscle tension and cramping to be positively correlated with subjective pain report (Lloyd, 1971; Norris, Gasteiger, & Chatfield, 1957) and elevated EMG activity (Norris et al., 1957; Thomas & Dale, 1976). Accordingly, the measures employed in the present study included other pain behaviors (in addition to screaming) in order to assess covariation of behaviors and EMG activity in order to assess muscle tension.

METHOD

Subject and Setting

The subject was a 24-year-old male of borderline intelligence (WAIS: Full Scale - 75; Verbal - 75; Performance - 76) diagnosed as having DMD at age 17. He had been repeatedly admitted to a multidisciplinary inpatient hospital unit for intensive treatment. A variety of drug treatments resulted in minimal improvement. At the time of the study, the subject had been readmitted because of a recent increase in screaming and self-reported pain. The subject's parents requested help in reduction of screaming as an alternative to seeking permanent institutional placement.

All sessions were conducted in two adjacent laboratory rooms, one equipped with a hospital gurney and the other containing electro-physiological equipment. Communication between the observers, therapist and monitoring personnel was facilitated by the presence of a window in the wall separating the rooms.

Sessions of the present study were conducted concurrently with those of a pharmacological assessment project. Additionally, other disciplines within the hospital, including physical therapy and occupational

therapy, evaluated the patient during the course of his admission to assist in determining the efficacy of drugs used to treat the dystonia. During the course of the study, no consistent treatment was in effect for screaming within the other disciplines, although, subsequent to the second intervention phase, a protocol was developed based on our findings and was implemented by the parents and hospital staff.

Apparatus

Based on the assessment of clinical involvement, the sites chosen for EMG monitoring were the flexors and extensors of the upper arm bilaterally. The recording of the integrated and raw EMG was made with silver-silver chloride electrodes filled with conductive paste and placed on alcohol-cleaned skin approximately 3-4 cm apart, covering the muscle along its axis (Yanagisawa, 1967). At the start of each session, the signals were checked on an oscilloscope and were monitored throughout.

Two Biofeedback Systems Model PA-2 pre-amplifiers were used with the low-pass filters set at 1000 and 10 Hz respectively, and with gain set at 1000 to amplify the raw EMG. In order to preserve a record of EMG activity, raw signals were fed into a Beckman R611 Dynograph recorder. Pre-amplifier and pre-amp multiplier sensitivities were set at 0.5 and 0.1, respectively.

The amplified raw EMG was also fed into Biofeedback Systems B-1 units that integrated and digitized the signals. An Intel 80/10 microprocessor calculated printouts of pulses over 20 s periods were displayed on a teletype.

Sessions

Behavioral observations were made during laboratory sessions structured to assess the effects of medication on the subject's muscle activity and task performance. The subject was informed that the EMG and task performance measures were used to determine the effectiveness of the medication in treating the neuromuscular condition, but was not aware of the behavioral contingencies. Sessions were conducted with the subject positioned on his back on a hospital gurney. In addition to the observer(s), a therapist was present throughout the sessions to implement treatments, provide materials, and instruct the subject on task performance.

One morning and one afternoon session were held each weekday. Times of sessions were varied to obtain samples of premedication and postmedication behaviors in both morning and afternoon time slots. Each laboratory session consisted of three separate phases: rest, range of motion, and tasks. During the rest phase, the subject was instructed to relax for 4 min. During the range of motion phase, the therapist flexed the subject's arm at the elbow from a relaxed

position at the side through an arc towards the shoulder. The arm was then returned to the initial position. Thereafter, the subject flexed and extended his arm through the same exercise without assistance. During the tasks phase, the subject performed manipulative tasks bilaterally, including: (1) pressing a standard telegraph key as many times as possible within 1 min; (2) stacking three 2 x 2 in plastic blocks in a preset order (medial to midline/lateral to midline; (3) transferring a horizontally arranged row of four plastic poker chips into a container placed midline to the subject.

The order of these components within sessions was randomly determined across sessions. Integrated EMG measures were monitored throughout each session with the exception of the range of motion segment during which dynographic EMG traces were recorded.

Behavioral Observations

Occurrence of pain behaviors was recorded throughout each 16-min laboratory session: rest (4 min); range of motion (8 min, 2 min each of passive and active range of motion for each arm); tasks (4 min, 1 min each of right and left key tap and 2 min of intervening tasks). Observer(s) stood next to the subject in a position to see his entire body. Partial interval occurrence (Powell, Martindale, & Kulp, 1975) of pain behaviors was recorded during 10 s

intervals, including: (1) facial contortions: wrinkling of forehead and/or space between eyebrows; raised eyebrows, lips drawn toward chin, eye closure in combination with any of the above; (2) screaming: sustained vocalization, above normal conversational intensity, of at least 2 s duration; (3) muscle contractions: visible spasms of musculature or postural changes secondary to spasms; (4) help-seeking behavior: hand gestures toward desired objects, requesting movement of objects, or requesting physical contact; (5) sharp expulsion of breath: rapid release of air with no specified pitch. For pain behaviors containing more than one component, occurrence was scored if any of the components was observed.

Following each session, self-reported pain ratings were also obtained from the subject using a 0 (no pain) to 5 (extreme pain) point scale. Since the subject was unable to communicate verbally, the pain rating was communicated via hand signals.

Observers were trained for 10 sessions immediately prior to the first experimental condition. Interobserver reliability for experimental sessions was obtained by having two observers record pain behaviors during 47% of all sessions. Reliability checks for predrug and postdrug sessions occurred at least once per experimental phase, with the exception of one predrug session following medication change. Interobserver interval reliability was calculated

according to the formula $[A/(A + D)] \times 100$, where A = number of agreements and D = number of disagreements. Frequency reliability scores were calculated by dividing the smaller by the larger count of each category. Occurrence, nonoccurrence, combined interval reliability, and frequency reliability were calculated for each reliability session for each of the five behaviors.

Mean reliability scores and ranges for predrug and postdrug sessions are reported in Table 1. The highest reliability occurred for the screaming category, the behavior chosen for intervention. Low interobserver agreement can be noted for some of the behavioral categories for occurrence or nonoccurrence indices, but the combined indices were over 80% on all measures. Frequency reliability for the four lowest overall reliability scores reported in Table 1 were: facial contortions, predrug 90%, postdrug 93%; and sharp expulsion, predrug 87% and postdrug 94%.

Experimental Design

The effects of noncontingent attention and a subsequent response cost contingent on screaming were examined in the context of a reversal design (Baer, Wolf, & Risley, 1968). The schedule of conditions and medication dosages is displayed in Table 2. The manipulated variable in this study was the level of attention provided to the subject.

Table I
Mean Reliability Scores Across Pre and Post Drug Conditions
for each Behavioral Category

Pre-Drug Sessions			
Behavioral Category	Occurrence	Nonoccurrence	Combined
Facial Contortions	81.3(64-94)*	70.3(39-95)	88.5(74-97)
Screaming	96.3(86-100)	99.1(92-100)	99.5(97-100)
Muscle Contractions	63.4(28-86)	86.7(71-99)	89.8(81-99)
Help-Seeking Behavior	51.5(0-100)	95.9(91-100)	96.1(92-100)
Sharp Expulsion	69.1(54-88)	66.9(40-89)	82.3(69-91)
Post-Drug Sessions			
Behavioral Category	Occurrence	Nonoccurrence	Total
Facial Contortions	80.6(60-97)	66.6(20-94)	86.8(67-97)
Screaming	90.9(50-100)	99.1(95-100)	99.5(98-100)
Muscle Contractions	61.6(33-76)	87.6(81-97)	90.3(83-97)
Help-Seeking Behavior	44.0(25-75)	95.8(87-100)	96.3(88-100)
Sharp Expulsion	73.9(56-87)	54.1(34-68)	81.2(71-90)

*Numbers in parentheses denote ranges

Table II

Number of Sessions and Medication Dosage per Condition

Condition	<u>Number of Sessions</u>			Medication Dosage
	Total	Pre-Med	Post-Med	
NA Attention-to-Screaming	5	2	3	Parsidol 100 mg., QID
NS Attention-to-Non-screaming	9	5	4	Parsidol 100 mg., QID
NA Attention-to-Screaming	9	5	4	Parsidol 100 mg., QID
NS Attention-to-Non-screaming	16	8	8	Parsidol 100 mg., QID
NS-50 mg. Attention-to-Non-screaming	2	1	1	Parsidol 50 mg., QID
NS-25 mg. Attention-to-Non-screaming	12	6	6	Parsidol 25 mg., QID

Attention consisted of: (a) continuous massage to painful areas, (b) verbal interactions with the subject on preferred topics and praise for task performance, and (c) drinks of preferred liquids upon request, regardless of screaming. During the baseline or Noncontingent Attention (NA) conditions, the subject was provided with attention, regardless of screaming. During intervention or Attention-to-Nonscreaming (NS) conditions, delivery of attention was terminated contingent upon screaming. Attention and physical contact, except for the minimum necessary to prompt task performance, were withdrawn upon occurrence of screaming during NS conditions but were again available upon cessation. Throughout all conditions, the subject received no instructions about the behavioral contingencies.

The subject's medication regimen for neuromuscular control to reduce pain included Tegretol and Parsidol (see Table 2). The dosage of Tegretol (not displayed in Table 2) remained constant at 50 mg QID throughout the course of the study. Parsidol (10H-Phenothiazine-10-ethanzmine, N, N-diethyl-a-methylmonohydrochloride) is a phenothiazine derivative orally effective as an anti-Parkinsonism drug. The drug exerts significant anticholinergic (parasympatholytic) actions including a marked influence upon neuromuscular symptoms. Parsidol dosage was maintained at 100 mg QID across sessions 1-39, 50 mg QID during

sessions 40-41, and 25 mg QID for sessions 42-53. Drug changes occurred following medical decisions to assess reduced dosage levels of Parsidol. The subject was not informed of these changes.

RESULTS

All pain behavior data are displayed so that premedication and postmedication sessions may be differentiated. Figure 1 shows the percentage of 10 s intervals in which screaming occurred per session, and shows that screaming was reduced during both NS conditions (NS 1 and NS 2). Furthermore, screaming was maintained at near zero levels during the last three sessions of NS 1 and throughout most of NS 2. The occurrence of screaming in both premed and postmed sessions increased during both drug change conditions, compared to NS 2 levels. Further, a difference in screaming was noted for premed compared to postmed sessions. This difference is more clearly depicted by the mean percent intervals of screaming per condition shown in Fig. 2. For combined predrug and postdrug sessions, screaming decreased from a mean of 41% during the first NA condition to 7% in the first NS condition. Similarly, after increasing to 21% in the second NA condition, screaming decreased to 1% in the second NS condition. Concomitant with reduction of medication dosage of Parsidol to 50 mg, and then 25 mg QID, screaming means increased to 19 and 7%, respectively. The mean occurrence of screaming was lower for postmedication compared to

Fig. 1. Per cent intervals of screaming per session

□ ATTENTION TO SCREAMING
 ▨ ATTENTION TO NON-SCREAMING

Fig. 2. Means per condition of other pain behaviors and self-reported pain during pre-drug, post-drug and all sessions.

premedication sessions for all conditions except the first NA condition.

Figure 2 also displays the mean occurrence per condition of other pain behaviors (facial contortions, generalized muscle contractions, sharp breath expulsion and help-seeking). Although screaming was the only behavior targeted for intervention, data for combined predrug and postdrug sessions indicate that occurrence of other pain behaviors also decreased during the first and second NS conditions compared to NA conditions. Further, pain behaviors covaried across the first four conditions for combined pre/post medications sessions. Mean occurrence of all pain behaviors except facial contortions increased in the NS 50 mg Parsidol condition. Further, increases in all pain behaviors except help-seeking behaviors occurred in the NS 25 mg Parsidol condition. A more pronounced behavioral treatment effect was seen for postmedication sessions compared to premedication sessions for all pain behaviors, except for help-seeking behaviors during drug changes.

The self-pain rating mean data for combined predrug and postdrug sessions (see Fig. 2) show a reduction during the NS conditions at the 100 mg Parsidol dosage level, that was not maintained across drug changes (NS 50 mg and NS 25 mg conditions). Again, treatment effects were more clearly demonstrated in postmedication sessions.

Figure 3 depicts a composite of the EMG levels for all

Fig. 3. EMG recordings in microvolts of muscle activity per session

four muscle groups (biceps and triceps bilaterally) sampled during each session, and are representative of the data obtained for each muscle group. EMG levels varied widely across all sessions but did not appear sensitive to the behavioral manipulations during the NS 1 and NS 2 conditions. Further, no relationship was evident between the relative magnitudes of EMG level and the subject's self report of pain. Mean EMG levels per condition for combined predrug and postdrug sessions were 715uV, in the first NA condition, 610uV in the first NS condition, 580 uV in the second NA condition, 545uV in the second NS condition, and 750uV and 505uV in the last two Parsidol conditions, respectively. Mean EMG levels were lower for postmedication compared to premedication sessions for all conditions with the exception of the last NS 25 mg Parsidol condition.

The usefulness of an A-B-A-B reversal design to assess the effect of an independent variable has been well documented (Baer, Wolf, & Risley, 1968; Hersen & Barlow, 1976; Kratochwill, 1978; Sidman, 1960). In this design, baseline data are collected to determine the present level of a behavior and predict behavioral outcome without an intervention. It is hypothesized that introducing an intervention (in this case attention contingent upon non-screaming) will produce a visible change from the baseline level of performance. The reliability of this change (or true functional control) is demonstrated by

replicating both the baseline and intervention phases.

For the behavior analyst, a significant change in behavior is determined by the social importance of the level of change observed. Baer, Wolf, and Risley (1968) suggest "if the application of a behavioral technique does not produce large enough effects for practical value, then the application has failed" (p. 96). In the present study, the application of attention contingent upon non-screaming resulted in a decision to postpone institutional placement of the subject. Thus, according to the standards of applied behavior analysis, the application resulted in a significant change in the observed level of screaming behavior.

Several models have been proposed to statistically analyze data from N=1 research designs. However, in the present case there are several lines of evidence that argue against the use of traditional statistical procedures. Probably the most widely used models are those based on analysis of variance (ANOVA) (Gentile, Roden, & Klein, 1972; Shine & Bowers, 1971). Hersen and Barlow (1976) suggest that a variety of studies have generally shown the robustness of ANOVA in handling violations of two of the three assumptions upon which the model is based (i.e., normality and homoscedasticity). However, if the assumption of independence is violated, ANOVA results are rendered useless, and the t or F tests become inappropriate. This assumption of independence refers to the correlation between

the error components of paired observations. Between-group designs assure independence of error components by random assignment of subjects to treatment conditions. However, in the case of repeated measures over time, the independence assumption is usually violated because successive observations in a time series design tend to be correlated.

Hartmann (1974) points out that serial correlation in data may inflate the degrees of freedom and lower the variability within phases, thereby yielding a positively biased F ratio. In fact, Sidman (1960) suggests that major advantages of single-subject designs include avoiding reliance on mean levels of performance and allowing changes within a phase to be examined over time.

One solution to this problem is the application of a time-series analysis to assess autocorrelation among data. Shine and Bower (1971) propose that a test for significant within-phase, lag-one correlation precede the ANOVA test presented by Gentile et al. (1972). The assumption here is that an ANOVA model is appropriate when serial dependency is non-significant.

However, Toothaker, Banz, Noble, Camp, and Davis (1983) showed that the Shine-Bower ANOVA and preliminary tests are seriously influenced by violation of the independence assumption. Toothaker et al. (1983) also point out that positive non-zero, serial correlation results in liberal alpha values and these tests even lack robustness for

non-significant serial correlation. Additionally, Cook and Campbell (1979) argue that at least fifty observations are needed to do a time-series analysis. Thus, it seems inappropriate to apply traditional statistical procedures to assess the impact of the present intervention.

DISCUSSION

The reduction of screaming during the first and second NS conditions demonstrated that this aspect of the subject's pain behavior could be brought under operant control. Since screaming had been described as the most noticeable and disruptive pain behavior, reductions to near zero levels in the second NS condition were of clinical significance. Importantly, other pain behaviors covaried with screaming, suggesting that under certain conditions the observed pain behaviors functioned as a response class with similar reinforcement histories. However, the existence of these behaviors as a response class has not been conclusively demonstrated here. This would occur in a study that experimentally manipulated first one and then each of the other pain behaviors. Additionally, low reliability for some pain behaviors other than screaming argues that conclusions regarding response classes be tentative, pending further research.

Interestingly, behavioral measures of pain (including self-report) covaried across the first four conditions, but the EMG data did not. The lack of covariation between EMG data and behavior during behavioral interventions had been frequently reported (Cataldo et al., in press) and in the

present study, may be due to a variety of factors: (a) the sites chosen for monitoring may not have been the sites in which contractions resulted in maximum pain experience; (b) the sites chosen may have been sources of intermittent as opposed to continuous pain, making the relatively brief laboratory observation periods insufficient to monitor such variations; (c) EMG may not be a sensitive biological index of pain in DMD; and (d) behavioral interventions may have impacted on the subject's behavioral response to pain, resulting in less screaming at the same level of pain sensation.

Throughout the study, differences were observed between behavioral and self-report data collected before and after medication administration. Pain behaviors appeared more sensitive to treatment immediately following medication administration. These data suggest that the combination of a behavioral procedure with medication is more effective in reducing pain expression behaviors and self-reported pain than using the behavioral procedure alone. Several explanations may account for this finding. The first possibility is that the apparent postdrug sensitivity was serendipitous. However, the pervasiveness of the effect across five behaviors, as well as self-reported pain, and across experimental conditions argues against a conclusion of results based on chance alone. A second explanation is the possibility of true medication effects. The medication

may have reduced physiological or respondent aspects of pain behavior, allowing greater demonstration of operant control, especially for corollary behaviors. This implies an interactive effect of medication and contingent environmental events. Unfortunately, the validity of this explanation cannot be evaluated within the design and dependent variable constraints of the present study, although increases in all pain behaviors and self-reported pain following unannounced medication dosage changes argues against a placebo explanation.

A cautionary note about the clinical application of behavioral approaches to pain is pointed out by these results on covariation. Because of the possibility that self-reported pain and other pain behaviors covary, the use of operant conditioning to eliminate a response which communicates current pain experience could pose a problem for medical management of patients, and could interfere with accurate medical assessment of biological status determined by patient report. In the present study, medication and behavior management techniques were used simultaneously and medication effects did not appear to be masked.

Nevertheless, the indication from these data that pain behaviors are members of a response class suggest the need for caution when interventions for pain are used in conjunction with assessment of pain behaviors. Future studies should be conducted so as to ensure the maintenance

of at least one appropriate but nondisruptive method of pain expression for continued successful medical management.

The demonstrated effectiveness of a behavioral intervention in reducing screaming behavior secondary to DMD suggests that behavioral procedures can be employed with this population, and thus delay or reduce the probability of institutional placement due to chronic pain behaviors that often preclude a normal living environment. Follow-up reports by the subject's parents for a 12-month period after discharge indicated clinically significant declines in screaming episodes and led to a decision to postpone institutional placement indefinitely. Since behavioral interventions have demonstrated promise for the alleviation of chronic pain syndromes (Fordyce, 1976), continued investigation of their disruptive and/or interactive effects in conjunction with medical management would represent an appropriate bio-behavioral approach.

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Figure 1. Schematic diagram of the experimental setup.

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