INTERPERSONAL INFLUENCES ON PAIN EXPRESSIONS

by

KENNETH MARTIN PRKACHIN

M.A., University of British Columbia, 1976

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

THE DEPARTMENT OF PSYCHOLOGY

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

June, 1978

© Kenneth Martin Prkachin, 1978

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Psychology

The University of British Columbia
2075 Wesbrook Place
Vancouver, Canada
V6T 1W5

Date June 30, 1978.

ABSTRACT

Increasing evidence suggests that social experiences critically determine the manner in which individuals respond to painful events. Of the variety of social determinants of pain responses, social modeling has been among the most extensively studied. Conclusive evidence is available showing that exposure to models who exhibit tolerance or intolerance for noxious electrical stimulation produces matching behaviour on the part of subjects. However, questions related to the breadth of the changes induced, and the applicability of these findings to naturally-occurring painful experiences require further investigation. The present series of studies examined some of these issues. Experiment 1 re-evaluated the impact of social modeling on sensory-decision theory (SDT) indices of the response to pain. Following a baseline pre-assessment of pain threshold and tolerance, 30 female subjects were exposed to models displaying tolerance or intolerance for the stimulation, or an inactive companion. Under conditions of influence, subjects' behaviour approximated that of the model. After these effects had been induced, subjects underwent a SDT series during which they were exposed to stimuli from low, moderate, and high levels of current intensity. Results indicated that intolerant modeling was associated with increased sensory sensitivity at noxious levels of stimulation. Tolerant modeling was not associated with differential values of sensitivity, suggesting that previous positive findings be qualified. Experiment 2 was concerned with the effects of tolerant and intolerant modeling on overt expressive displays. Videotapes taken of subjects in

Experiment 1 were presented to 15 female observers who attempted to predict the levels of current that observed subjects were experiencing. SDT analyses of observers' judgments indicated that responses to intense stimuli were more readily discriminated than responses to less intense stimuli. The behaviour of subjects exposed to a tolerant model was less discriminable than that of intolerant subjects. The behaviour of intolerants was less discriminable than that of controls. It was argued that tolerant modeling produces reductions in overt, nonvocal expressions of pain. Experiment 3 examined whether modeling effects could be obtained with naturally-occurring groups, and the relative power of pain tolerant and intolerant behaviour. 127 female undergraduates underwent a screening for pain threshold levels. In a subsequent session, subjects participated either individually, or in pairs comprised of all combinations of subjects having high and low thresholds. Unidirectional influence was observed, with low threshold subjects inducing high threshold subjects to report pain sooner, and accept fewer currents. These results indicated that pain intolerant behaviour may be a more powerful social influence than pain tolerant behaviour, probably as a result of its imperative nature. Since the modeling effect was observable among naturally-occurring groups, the generalizability of laboratory to naturally-occurring pain phenomena was supported. Relationships between measures of pain based on psychophysical judgments and overt behaviour were examined within the context of a model that suggests that inducing alterations in pain behaviour may modulate the experience of pain.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACKNOWLEDGEMENTS

A large number of people have contributed significantly to the development of this dissertation. All members of the dissertation committee have made direct, significant, and independent contributions. They are: Drs. Kenneth D. Craig, Park O. Davidson, Robert Knox, and Lawrence M. Ward. I owe Dr. Kenneth Craig special gratitude for his continuous support and assistance throughout my graduate career. Special thanks also go to my good friend, Cindy Gosline, for her assistance in all aspects of the project; in particular for conducting Experiment 2 under sometimes extremely adverse circumstances. Luz Piedrahita, Diana Piedrahita and Liz Zischka served as models in Experiment 1. Dani McCullough gave generously of her time to aid in some of the more tedious and aversive chores. Judy Hawkins, L. Naylor, and H. Boudreau typed various parts of the manuscript. My very dear friend, Georgia Nemetz, came to my rescue during one particular period of emergency. Finally, I would like to thank Glenda Midgley for her help and encouragement during all phases of this dissertation.

INTRODUCTION

The current proliferation of research into the anatomy, neurophysiology, and psychology of pain has been attributed, in part, to a shift from a disease-model orientation that considered pain to be noteworthy only as a symptom of underlying pathology, to a perspective viewing pain as a phenomenon worthy of study in its own right, independent of, or in relation to, pathological processes (Fordyce, 1976b). Coupled with this change in perspective and expansion of research has been an increased appreciation of the complexity of the experience. To a large extent, such appreciation has derived from modulation studies which have demonstrated that responses to painful events can be influenced by a wide variety of chemical, surgical, and environmental manipulations. Although several theories attempt to integrate the processes through which modulation occurs (Chapman, 1977; Melzack & Wall, 1965; Melzack, 1973; Mayer, 1974), the variables that are capable of modulating responses to pain are so diverse that no current formulation seems entirely satisfactory.

The research to be reported herein dealt with the effects of social environment manipulations on human pain responses. In part, this research represented an attempt to examine the breadth of the changes induced across a variety of indices of response to noxious stimulation. A further aim was to collect data pertinent to socio-behavioural accounts of the origins of individual differences in response to painful events.

In the following section, current formulations of pain will be reviewed briefly. Subsequently, a more detailed explication of the rôle of social events in determining responses to pain will be outlined. Finally, attention will be paid to methodological issues relevant to the

studies to be reported in the sequel,

Pain Perspectives: An overview

Traditional perspectives have characteristically employed a stimulus-response formulation in accounting for pain (Fordyce, 1976b). The basic model is as follows. Adequate stimulation activates peripheral nociceptors which convey nociceptive information centrally to lower and higher brain centers. Activity in these centers determines the perception of pain and the behavioural response to noxious stimulation. Research deriving from this perspective has focussed on the biophysical characteristics of relevant peripheral structures, the anatomy and physiology of ascending sensory systems, the localization of pain-relevant structures in the brain, and the psychophysical characteristics and capacities of the molar system.

This traditional perspective, most closely associated with the specificity theory of von Frey (reviewed in Melzack & Wall, 1970), has had major consequences for pain research such as the identification of peripheral and central structures and systems that are critically involved in pain processes. Equally important, however, have been advances brought about through recognition of the empirical inadequacies of this position. As Melzack (1973) and others have pointed out, the traditional perspective fails to account for a variety of puzzling phenomena, such as phantom-limb pain, the unpredictable effects of surgical lesions of pain-relevant neural pathways and structures, and the not infrequent observation of lack of correspondence between the occurrence of noxious events and evidence of pain. Further, it has little to say about central or

experiential factors involved in pain modulation.

Since modulation of pain responses can be brought about through a variety of physiological and psychological procedures (cv. Bonica & Albe-Fessard, 1976; Weisenberg, 1977), a complete account of pain must adequately deal with both sources of such modulation, employing principles appropriate to each. Currently, the most comprehensive and integrated formulation of pain processes derives from anatomical, biochemical, and neurophysiological work.

Gate-Control Theory (GCT) (Melzack & Wall, 1965; Melzack, 1973) has been a critical impetus to the expansion of pain research (Liebeskind & Paul, 1977), and represents an attempt to account more fully for the paradoxes facing earlier formulations. As such it involves an increase in complexity and a departure from the strict stimulus-response nature of earlier formulations. GCT rests upon a description of current knowledge of the anatomical substrate of pain-related behaviour; however, its fundamentally novel contribution lies in its application of the principle of inhibitory control of sensory input. According to this position, processes producing modulation of nociceptive input can be activated either presynaptically, prior to the central evocation of pain perception, or via descending inhibitory activity resulting from the action of central regulatory mechanisms. Pain modulation is presumed to occur via activation of a gating mechanism, the anatomical locus of which is to be found in the spinal cord substantia gelatinosa. In addition to the hypothetical spinal gating mechanism, GCT proposes that different ascending spinal tracts mediate different aspects of pain perception: a neospinothalamic tract-thalamus-somatosensory-cortex system subserving sensory-discriminative

aspects of pain, and a paramedial ascending system-thalamus-limbic system path subserving affective-motivational aspects. (Recently Dennis and Melzack (1978) have reviewed evidence for at least three ascending pain-signalling systems.) The GCT notion of descending inhibitory control has been robust and recent accounts of the mode of action of various antinociceptive procedures such as morphine analgesia, stimulation-produced analgesia, and acupuncture have relied heavily upon it (Mayer & Price, 1976; Mayer, Price, Raffi & Barber, 1976). Further, since the pain systems implicated in GCT all project to and receive projections from higher brain centers, it has been argued that these systems may mediate the pain-modulatory effects of various experiential and "cognitive" influences. Hall (1977), for example, has argued that hypnotic or waking, imagined analgesia is produced through an inhibition of activity at the spinal gating mechanism. The demonstration that experiential variables are capable of affecting pain responses may be consistent with GCT. However, such demonstrations do not represent confirmatory evidence, nor does the existence of a mechanism for central regulation of noxious input imply that this is the system through which such influences exert their effect.

Concurrent with recent advances in the understanding of the anatomical, biochemical, and neurophysiological factors subserving pain has been an increase in attention directed toward the role played by psychosocial variables in the modulation of pain responses. It has long been accepted that factors involved in an organism's behavioural history and current social conditions may influence responses to noxious stimulation or the emission of behaviour indicative of pain. Evidence for this point has come from many sources, including casual and clinical observation, and a multitude

of systematic studies of such diverse variables as personality traits, cognitive styles, cognitive strategies, affective states, preparatory information, hypnosis, and so on (see Weisenberg, 1977, for a review). While there is little disagreement regarding the substance of this research, there is equally little agreement with regard to the active mechanisms involved, their locus of operation, and the generality of the findings. Additionally, the very diversity of these factors defies the development of a coherent, systematic theoretical framework within which their modes of action would be adequately accounted for.

Since the research to be reported herein dealt with the role of socio-environmental variables in pain modulation, it will be necessary to discuss current understanding of how such factors are relevant to pain modulation processes.

Pain is ordinarily described as a private, subjective experience. Scientific discussions of the topic typically deal with sensory mechanisms. In recent years, however, it has become increasingly apparent that a productive approach to the study of pain-related processes lies in investigation of their behavioural aspects. Painful events have behavioural consequences; in fact, pain is invariably inferred from behavioural observation. Sternbach (1968, p.8) notes: "... it is necessary for the person to do something ... in order for us to determine that he is experiencing pain." Similarly, Fordyce (1976, p.153) has stated:

> Clinically, pain cannot become a problem until someone communicates that pain isbeing experienced. The patient grimaces or moans, talks about the quality and location of the pain, limps or otherwise moves in a guarded manner, or displays autonomically mediated indications of distress.

Other authors have made similar points (Craig,Note 1; Szasz, 1968;

Zborowski, 1969).

Virtually all studies of pain in intact organisms employ behaviourally-based dependent measures although some make use of concurrently-recorded physiological responses as well (Craig & Prkachin, 1978). Since pain is a phenomenon that is intimately tied to behavioural expression, three related consequences follow. First, pain expressions are capable of exerting an influence upon the social environment in which they occur. Thus, pain expressions are likely to provoke characteristic changes in the behaviour of members of the social milieu (Craig, 1978b). The nature of the changes that occur will be dependent upon a variety of factors including the situational context in which they occur, behavioural characteristics of those present when they occur, and parametric characteristics of the displays themselves, including their intensity, frequency, and chronicity. Second, social consequences are likely to exert reciprocal influence, provoking immediate and long term effects on the expressions themselves. Third, expressions of pain are likely to be subject to modulation via other social processes effective in controlling behaviour.

Social events, pain experience, and behaviour

There are two major areas of interst when considering interrelationships between social events and pain expressions. The first concerns characteristic effects of pain expressions on the behaviour of other. The second deals with the question of what influence these events have upon current and subsequent pain experience and expression.

Effects on the behaviour of others. It is a common observation that expressions of pain and suffering have a powerful impact on the

behaviour of others. Episodes of acute pain provoke rapid and salient sequelae in the behaviour of others: expressions of sympathy, comforting, diffuse "emotional" responses, and interventions that alleviate the source of distress, to list but a few. The power that such expressions have over others even during periods of protracted pain and among caretakers who have extended experience of exposure to pain displays is illustrated by clinical observations of patient-staff interactions on a burn-pain unit:

> Staff members are constantly saying to the patient, "It will be over soon." "Just a bit longer." Patients are constantly crying out "For God's sake, hurry !" (Fagerhaugh, 1974, p.646).

When a pain problem becomes chronic, the corresponding increase in the duration of exposure of members of the immediate social milieu is likely to produce permanent adjustments in their behaviour (Fordyce, 1976b; Sternbach, 1974). Unfortunately, the current state of knowledge does not allow an adequate amount of precision in predicting these changes.

Early laboratory research involving vicarious exposure of subjects to the suffering of others demonstrated the provocative autonomic/emotional consequences of pain displays (Berger, 1962; Craig & Lowery, 1968). Such investigations neglected the overt accompaniments of autonomically-mediated events that are necessarily critical in the social influence process. However, later research has suggested that the occurrence of such responses is predictive of overt attempts at relief and comfort (Bleda, 1975; Krebs, 1975).

Social events implicated in pain modulation. Since pain behaviours are publicly observable and occur in a social context there is every reason to believe that they are susceptible to modification and maintenance by any

of a host of variables shown to be pertinent to the modification and maintenance of other forms of behaviour. While this is clearly an area of great research potential, few large-scale, systematic studies have been attempted and, therefore, evidence bearing on the issue is largely the result of clinical observation.

Fordyce (1976b) has provided a detailed analysis of historical and current environmental factors that predispose an individual toward the emission of high rates of pain behaviour. First of all, pain behaviour may, historically or currently, have been consequated by direct positive reinforcement in several forms, social attention, protection, and reassurance from significant others, compensation, or iatrogenic reinforcement represent a few examples). Particularly interesting is the potential for mutual reinforcement in dyadic interaction. The person exhibiting pain may be reinforced for so doing by the behaviour of the other. Reciprocally, the act of reinforcing pain behaviour may be reinforced by reductions in the pain displays of the individual whose pain behaviour was reinforced. Secondly, pain behaviour may acquire strength through processes of avoidance learning. For example, pain behaviour emitted in the context of personally aversive social situations may be successful in terminating or avoiding them. Thirdly, an elaborate repetoire of pain behaviours may occur among individuals lacking a history of sufficient reinforcement for "well behaviour."

The numerous case examples and single-subject experiments reported by Fordyce and his co-workers provide ample illustrations of the modicication of pain behaviour occurring as the result of alterations in the response of the social environment to pain displays (Fordyce, 1976a, 1976b; Fordyce,

Fowler, Lehmann, DeLateur, Sand, & Trieschmann, 1973; Fordyce, Fowler, & DeLateur, 1968).

There are alternative sources of information suggesting that the response to pain is largely and sensitively modulated by social experiences. Studies of the response of various ethnic groups to disease-states or experimental pain are consistent with the conclusion that members of some cultures exhibit characteristic and stereotyped pain behaviour that is differentiable from the response of other groups. Several investigators (Sternbach & Tursky, 1965; Tursky & Sternbach, 1967; Weisenberg, 1975) have demonstrated social and ethnic differences in response to experimentally induced pain among varying ethnic and social groups. Further, ethnically-defined groups have been shown to exhibit characteristic changes in pain behaviour in response to the manipulation of social bariables designed to provoke intergroup competitiveness (Lambert, Libman, & Poser, 1960). Subjects from Jewish and Protestant backgrounds who did not differ in a pretest of pain tolerance, were told that their particular ethnic group could not tolerate pain as well as the other groups. Jewish subjects exposed to this manipulation exhibited a subjequent increase in pain tolerance which Protestants did not.

As Craig,(1978b) has pointed out, the existence of similarities in the response of members of a particular cultural group to painful events represents presumptive evidence for the operation of socialization experiences in determining pain behaviour. Relevant experiences are likely to include exposure to group members displaying culturally-acceptable responses in circumstances of pain and distress. This observation implicates another source of environmental influence -- social modeling -- in the

acquisition of styles of response to pain.

The ubiquity and importance of vicarious experience in the acquisition of complex repertoires of behaviour have been comprehensively documented over the years by Bandura (Bandura & Walters, 1963; Bandura, 1969, 1971, 1976), who notes that "... virtually all learning phenomena resulting from direct experiences can occur on a vicarious basis through observation of other persons' behaviour and its consequences for them" (Bandura, 1969, p.118). Modeling processes are implicated not only in the acquisition of new forms of behaviour via observational learning, but also in the alteration of probabilities of occurrence of patterns of behaviour already in the individual's repertoire.

Of particular interest in the present context is the efficacy of vicarious exposure in the reduction of avoidance behaviours. Research applying modeling procedures to subjects exhibiting phobic avoidance has demonstrated that modeled displays of progressively more intense interaction with and approach to phobic objects produce reductions in avoidance behaviour comparable to or greater than those observed as a consequence of systematic desensitization (Rachman, 1972; Bandura, Blanchard, & Ritter, 1969). The implications of such studies for pain research are clear, since avoidance comprises much of what is characterized as pain behaviour. Similarly, to the extent that avoidance behaviour can be reduced via modeling procedures, it may also be enhanced by modeled displays of avoidance.

Research on social influence via modeling procedures has had important consequences in three not unrelated respects. First, such research has uncovered a major source of variation in social behaviour. Second, modeling research has led directly to the development of procedures

effective in altering problematic behaviours, particularly those characterized by avoidance. Third, principles derived from modeling studies have been employed in theoretical accounts of the origins of various forms of social/emotional behaviour. As one example of the latter, the acquisition of fearful avoidance in the natural environment has been attributed to the modeling of fearful behaviour observed in the context of certain stimulus cues (Rachman, 1972; Bandura, 1969, 1976). More germane to the present discussion, Fordyce (1976a), Craig (1978b) and others have argued that modeling effects are direct and significant determinants of responses to pain. In particular, relative tolerance or intolerance of noxious stimulation may largely be the product of exposure to others displaying relative tolerance or intolerance of similar stimulation. Stylistic differences in the particular forms of pain behaviour emitted in such contexts also are likely to be mediated by modeling processes.

Evidence that modeling processes are operative in the modulation of pain expressions in natural settings comes from a variety of sources.

It has been noted clinically (Fordyce, 1976b), and in an uncontrolled questionnaire study (Gentry, Schows, & Thomas, 1974) that a disproportionate percentage of chronic low back pain patients report the presence, in their immediate families, of relatives who suffered from low back pain or other physical disabilities, and who conceivably could have served as models for pain behaviour. Fagerhaugh (1974) in discussing the management of pain expression on a burn-pain unit notes:

> The patients on a burn unit represent a group who are in various stages of the burn and pain trajectories. These conditions give every patient a chance to rehearse and interpret his own illness and its pain trajectory and to compare his state to that of others. Through these activities

> he learns the norms and limits of pain expression and relief associated with various phases of the illness; the probable duration of the various phases; the various methods of tolerating pain; and the complications that may alter his pain trajectory. (p.647)

Several studies of children with abdominal pain provide further naturalistic evidence interpretable in terms of modeling effects. Apley and Naish (1958) contrasted 100 children exhibiting recurrent abdominal pains with comparable children not experiencing pain. The incidence of similar complaints among members of symptomatic children's immediate families was approximately six times greater than the incidence among control children. Oster (1972), in a questionnaire study, contrasted the family pain histories of children suffering from abdominal, headache, and limb pains with those of children without pain. Twenty-four percent of parents of children with pain reported pain problems in childhood or at the time of investigation in contrast with 14% among parents of children without pain. The conclusions reached in both of these studies were similar: recurrent pain problems in children may often represent a characteristic familial reaction mediated through imitative processes.

Direct evidence that modeling processes are active sources of pain modulation comes from laboratory studies. Craig and Weiss (1971) exposed undergraduate volunteers to six series of electric shocks gradually increasing in intensity. Subjects rated each shock on a categorical judgment scale ranging from "undetectable" to "painful". A confederate peer model who was ostensibly another subject undergoing the same procedure either dissimulated greater or lesser tolerance than the actual subject by making lower or higher ratings, or made ratings that were not contingent upon those of the subject. Subjects' behaviour matched that of the models

in the active modeling conditions, with those subjected to a tolerant model accepting substantially greater current intensities before reporting pain than those exposed to an intolerant model. Subjects exposed to the noncontingent co-participant accepted intermediate levels. The robustness of this phenomenon was demonstrated in later studies that employed a different methodology (Craig & Weiss, 1972; Craig, Best, & Reith, 1974). A standard current intensity, invariably described as non-noxious by uninfluenced subjects, was rated by volunteers over a series of trials. Subjects exposed to an intolerant model rated the current as painful 77% of the time while control subjects only did so 3% of the time.

Pain modulating effects of modeling were also demonstrated by Neufeld and Davidson (1971), who employed radiant-heat stimulation for pain induction. Subjects who observed another person experiencing the stimulation without distress showed an amount of pain reduction equal to that induced when subjects listened to detailed descriptions of the heat-induction process. Chaves and Barber (1974), employing pressure-induced pain, reported that observing an experimenter modeling "cognitive control" strategies resulted in reductions in pain reports among subjects who had high pretest pain thresholds.

Conceptual and Methodological Issues

The evidence reviewed demonstrates that modeling procedures have an impressive impact on verbal pain expressions and suggests that such processes may be active determinants of pain behaviour in natural settings. It is relatively easy to produce changes in pain expressions through manipulation of

social conditions. However, simple demonstrations of such effects have raised more complex issues pertaining not only to the parameters governing them, but also to alternative and concurrent processes through which the effects may be mediated.

Of particular concern in recent pain research, have been two issues: how dependent are pain modulation effects upon where the investigator chooses to look for them (i.e., how general are the effects across a variety of dependent measures), and are the effects superficial or fundamental (i.e., do the effects merely represent examples of the plasticity of behaviour, or are they mediated by changes in basic perceptual systems?) These questions are of particular significance because the wide variety of procedures that can effectively yield alterations in indices of pain may govern changes in different indices or may yield their effects via different mechanisms.

Owing to the presence of a comprehensive and perhaps paradigmatic formulation of pain processes -- Gate Control Theory -- it has become relatively common to relate observed phenomena of pain modulation to its concepts, or to imply that they are accounted for in its terms, thus halting inquiry much in the manner of Skinner's concept of the "explanatory fiction" (Skinner, 1974). However, as Liebeskind and Paul (1977) point out in their review of measurement issues in physiological studies of pain modulation in animals, studies often pay insufficient attention to the fact that the different pain indices measured are organized in different ways and at different levels in the nervous system. Treatments failing to affect spinal reflex manifestations of pain, for example, may affect pain measured by vocalization. The point is equally pertinent to studies of environmental or

psychological variables. Different indices may exhibit differential reactivity to different treatments. A mapping of the variety of parameters that are influenced by a given procedure should give clues not only to the generality of the changes that it produces, but is also likely to suggest further mechanisms that may mediate or modulate the effect. For this reason, it has been advocated that studies of putative pain modulation procedures evaluate their effects over a range of dependent measures.

One manner in which this has been attempted in studies of modeling influences on human pain has been through the assessment of changes in autonomically-mediated responses. In an early study, Craig and Niedermayer (1974) monitored skin conductance and heart-rate activity among subjects exposed to differentially pain-tolerant models. Subjects were exposed to two series of incremental electric shocks, signalled by the onset, six seconds prior to shock administration, of a light, and rated each on a 5-point categorical judgment scale. The study replicated earlier ones in that subjects exposed to a tolerant model accepted higher current intensities and those exposed to an intolerant model accepted lower intensities before describing them as painful than did subjects in two control conditions. Interestingly, in spite of the fact that the groups differed substantially in the amount of current accepted, they could not be differentiated on measures of the magnitude of skin-conductance or heart-rate change to the shocks. The authors took these findings as evidence that the modeling procedure had produced alterations in the biophysical processes subserving subjective experiences of pain and discomfort. Three major difficulties with this study required cautious interpretation of the findings. First, the findings were essentially negative and the

conclusions were taken as evidence that the null hypothesis was correct. Second, the use of a warning stimulus may have introduced alterations in the dependent measures that masked more directly interpretable effects. Third, the choice of skin conductance as a dependent measure may have been inappropriate. As Tursky (1974) subsequently pointed out, skin-conductance tends to exhibit ceiling effects and may thus fail to differentiate higher from lower current intensities. As an alternative measure, Tursky advocated the use of skin potential recorded from forearm and abdominal sites. In an attempt to re-evaluate and extend this earlier study, Craig and Prkachin (1978) monitored skin-conductance, heart-rate, forearm and abdominal skin-potential responses to electric shock among subjects exposed to either a tolerant or an inactive "co-participant". Subjects generated numerical magnitude estimates to shocks presented during a single ascending series, and a series of randomly-presented shocks at five standard intensities. Subjects exposed to a tolerant model exhibited significantly lower degrees of heart-rate acceleration to the current, and, unlike control subjects, the magnitude of their forearm skin-potential responses habituated over the course of the random series. Thus, this study provided positive evidence for the reduction of autonomically-mediated responses as a function of exposure to pain-tolerant social modeling.

The question of whether pain modulation resulting from social influence procedures may be mediated by fundamental alterations in sensory/perceptual processes has been addressed in two different ways. The first has been to employ S.S. Stevens' power law (Stevens, 1975) and numerical magnitude estimation tasks. The power law states that the perceived magnitude of a sensation (Ψ) grows as a function of the physical magnitude

of the stimulus (ϕ) raised to some power (η). The critical parameter in this procedure is the exponent (η) which is traditionally interpreted to reflect the operating characteristic of sensory receptors with separate sensory modalities possessing a "true" value (Craig, Note 1) While alternative interpretations are available, there seems to be agreement that the exponent is descriptive of rates of growth of perceptual magnitude.

Craig, Best, and Ward (1975) employed the standard tolerant modeling, intolerant modeling, and control conditions while requiring subjects to generate estimates of the magnitude of discomfort provoked by, and physical intensity of electric shocks presented in ascending series on 10-point scales. Power functions were fitted to the data of individual subjects via linear regression of the logarithms of numerical responses on the logarithms of the geometric mean of stimuli associated with each response category. No differences between the groups on the value of the exponent were found. However, since individual subjects' data were not well fitted by the standard procedure, an alternative method was employed to estimate ideal power functions. This method (Teghtsoonian, 1971) expresses the value of the exponent as a function of the ratio of the largest to the smallest response value divided by the ratio of the largest to the smallest stimulus value, and thus is range-corrected. Exponents derived by this technique were significantly lower in the tolerant group than in the two other conditions. This finding prompted the conclusion that the tolerant modeling strategy had altered fundamental qualities of the experience of pain. Craig (1978) employed power function analysis in a study that manipulated communication channels across different groups. Five groups of subjects generated numerical estimates of the magnitude of electric

current applied in ascending series. Subjects employed an open-ended scale modified from Hilgard, Ruch, Lange, Lenox, Morgan, and Sachs (1974) that anchored their responses at "0" for "undetectable," "1" for "detectable," "10" for the point at which they would ordinarily wish to stop accepting currents. Subjects were encouraged to continue accepting shocks and to make proportionate ratings after giving a rating of "10." In group 1, standard tolerant modeling procedures were employed, with both subject and model providing concurrent ratings. Other groups varied according to whose information was available to whom. In group 2, only the subject verbalized her responses, in group 3 only the model verbalized, in group 4, both were silent, and in group 5, only the subject underwent the task, while the confederate remained explicitly inactive. Conventional linear regression of response magnitudes on stimulus magnitudes was employed in order to derive parameters of the power function. Analyses of values of the exponent revealed that the group exposed to standard interactive tolerant modeling and the group in which information regarding the model's rating was available to the subject exhibited lower values of the exponent relative to the inactive model control group. Why the conventional mode of analysis failed to discriminate groups in the first study yet did in the second is unclear. The reason for this may have had to do with differences in the tasks employed across the two studies. In the Craig, Best, and Ward (1974) study, subjects employed a 10 point rating scale anchored at the upper end by the descriptors "high intensity" or "painful." A rating of 10 terminated each test series. By contrast, subjects in Craig (1978) employed an open-ended scale and were instructed to use a rating of "10" for the

point at which they would ordinarily wish to terminate the series. The nature of the subjects' task in the first study may have artifactually altered their rating behaviour. A further possible source of the discrepancy may have been due to differences in the subjects' behaviour in the two studies. The mean of terminal current levels accepted by all groups in Craig, Best, and Ward (1974) was 5.7 milliamperes (mA) while that in Craig (1978) was 10.8 mA. Finally, in Craig et al. (1975) subjects only rated the currents up to their first report of pain ("threshold") while in Craig (1978) subjects rated currents beyond this point. The above-noted methodological issues aside, it would seem that the exponent of the power function relating stimulus intensity to sensation magnitude may exhibit systematic alterations associated with variations in modeling conditions.

A second approach to assessing the nature of the changes produced in verbal rating indices of pain behaviour as a function of exposure to social influence conditions has been the use of signal-detection, or sensory-decision theory (SDT) methods (Green & Swets, 1966; McNicol, 1972; Pastore & Scheirer, 1974.) Since the present research made extensive use of SDT methods, and since there is currently a great deal of activity and controversy with respect to the application of SDT methods to pain research, this approach will be reviewed in some detail.

Signal Detection Theory and Experimental Studies of Pain Modulation

Traditionally, studies of pain modulation have employed verbal rating tasks, and have been concerned with determining the extent to which the independent variables of interest are associated with alterations in

pain threshold or pain tolerance. The point has already been made that a large number of variables are capable of producing alterations in these parameters; in fact, the reactivity of such measures to multiple sources of influence was partially responsible for the development of the double-blind experimental design (Beecher, 1959). Clark (1969), however, argued that such measures provide limited information because they unavoidably confound the subject's perceptual capabilities with independent aspects of his or her test-taking behaviour. When a subject's performance in a pain experiment changes such that a level of stimulation previously described as painful is no longer so described, this change may reflect at least two unrelated changes: (1) sensory processes may have been altered such that the subject no longer perceives the stimuli in the same way, or (2) sensory processes may have remained unaffected and the subject may simply exhibit a generalized tendency to alter the frequency with which he or she emits a particular response (e.g., "that is painful"). SDT provides a methodology based on probability theory for assessing these two aspects of performance, respectively termed discriminability and response bias.

The SDT conception states that a subject's performance on perceptual tasks is partially determined by decision-making processes. Given the task of deciding to which of n classes of stimulus event a particular exemplar belongs, the subject's response will be determined by a number of factors, including the prior probability of occurrence of a given class, the reward associated with an error, and the magnitude of the differences between the pertinent classes of event. Only the latter reflects sensory performance.

In the simplest type of signal-detection task, an individual is presented with a series of trials during which one of two events may occur.

The subject is simply required to report whether a particular event (a signal) did or did not occur. Four possible outcomes are associated with this kind of task: (1) the individual may correctly report the occurrence of the event on a given trial (a "hit"), (2) s/he may report that the event did not occur (a "miss"), (3) s/he may report that the event occurred in spite of the fact that it did not (a "false alarm"), or (4) s/he may correctly report that the event did not occur (a "correct rejection"). It is assumed that the signal and the non-signal ("noise") events each provoke an experience on the part of the subject, and that the magnitude of each event-provoked experience varies according to some specifiable distribution (typically normal). Assuming normal distributions of the experience provoked by signal and noise, the positions of the curves descriptive of the experiences can be plotted in relation to one another by examining the probabilities of making a hit and a false alarm. This follows from the assumption that the observer adopts a fixed criterion, set at a particular value along the continuum of sensory experience, and adopts a decision-rule; any sensory experience that exceeds the criterion value will be identified as a signal, any experience which does not exceed this criterion value will be identified as noise. If these assumptions hold, then the probabilities of occurrence of false-alarms and hits, respectively, define the area under the curve of the noise and signal distributions lying to the right of the criterion. Since the two curves are fixed in relation to one another by the areas cut off by the criterion, it is possible to express their distance from one another in standard-score units of the noise distribution. This distance, termed $\underline{d}'$, is a pure measure of sensory sensitivity,

or the discriminability of the two events. The procedure also provides a second independent parametr descriptive of where the observer has placed his or her criterion, thus indexing the subject's bias toward reporting or not reporting the event. This parameter may be expressed in terms of likelihood-ratio -- the ratio of the height of the ordinate of the signal distribution at the criterion to the height of the ordinate of the noise distribution at the criterion (L_x or β) -- or as the value of the criterion in standard-score units of the noise distribution. Individuals may adopt very lax or very strict criteria for reporting the occurrence of the event. If the criterion is very strict, false-alarm rates will be reduced, but so will hits. Alternatively, if the criterion is very lax, both hits and false-alarms will be increased. In the case of L_x or β , a value exceeding 1.00 indicates bias against reporting the event, while a value of less than 1.00 indicates bias in favour of reporting it. This basic paradigm can be modified to accommodate a variety of stimulus presentations and a variety of rating tasks and, therefore, is readily adaptable to pain research.

The first application of SDT methods to pain research was performed by Clark (1969) who evaluated the effect of placebo administration on ratings of thermal pain via traditional (threshold) and SDT procedures. Since that time, pain modulation studies employing SDT procedures have expanded vigorously. There is no need to review the substantive findings from this overall field of research since comprehensive reviews are available elsewhere (Hall, 1977; Lloyd & Appel, 1976; Rollman, 1977). Applications of SDT methods to the study of social modeling influences on pain will be discussed presently.

Criticisms of SDT pain research

The SDT approach has provoked considerable excitement in the field of pain research, owing to its ability to extract independent parameters descriptive of subjects' sensory performance (discriminability) and test-taking set (response-bias). However, several recent papers have criticized the approach on conceptual, methodological, and substantive grounds (Hayes, Bennett, & Mayer, 1975; McBurney, 1975, 1976; Rollman, 1977).

Both McBurney and Rollman have charged in one way or another that pain is a subjective experience defined by affective responses, and that since the SDT approach does not deal directly with affective responses, it is inappropriate as a method for the study of pain. As Chapman (1976) has argued, however, this criticism reflects a limited view of the phenemena of pain. Current accounts emphasize its multi-dimensional nature (Melzack & Casey, 1968; Crockett, Prkachin, & Craig, 1977). While affective components are crucially important, this does not mean that information regarding its sensory-discriminative aspects is trivial. Because pain is a multi-dimensional experience, including both sensory and affective components, studies that examine both aspects may provide particularly important information. The study by Craig and Prkachin (1978), cited earlier, provided evidence that exposure to a pain-tolerant social model is associated with reduced values of d' and reductions in autonomic and self-report indices of distress.

Rollman (1977) has attacked the SDT approach on a variety of grounds and there is vigorous debate in the literature on the legitimacy of the criticisms (Chapman, 1977; Hall, 1977). Two major conceptual points are

levelled. The first is that SDT pain researchers tend to equate the sensitivity parameter with physiological processes, and the bias parameter with emotional or psychological processes. While there are instances in which researchers have made such claims (Lloyd & Wagner, 1976), they are neither essential nor common in SDT pain research (Chapman, 1977). Rollman's second major conceptual point is that all SDT pain research adheres to four assumptions: (1) a reduction in neural activity can produce a reduction in experienced pain, (2) a reduction in neural activity will produce a reduction in d', (3) a reduction in d' indicates a reduction in experienced pain, (4) a reduction in experienced pain will be reflected in a reduction in d'. Examples are cited of instances in which any or all of these assumptions might be incorrect. Chapman (1977, p.300), however, has pointed out that inferences about neural processes are both unnecessary for and irrelevant to SDT pain studies which employ the technique "... as a probability model for perception and decision making that has no particular physiological reality."

A major methodological point is that SDT pain experiments measure discrimination, not detection. The measurement of detection requires the use of a "zero stimulus", which subjects rarely confuse with noxious stimuli. There are methodological alternatives to this problem (Chapman, 1977). However, as Hall (1977) has pointed out, Rollman's suggestion may involve a confusion between zero stimulus units and zero units on the "sensory continuum." In any event, SDT pain studies that do not employ a zero stimulus still measure discrimination which is a fundamental aspect of the pain experience. Despite these methodological and interpretive controversies, it

can still be asserted that SDT methodology can be effectively employed in separating discriminative capabilities and decision processes in relation to painful experiences.

RATIONALE

Developing an account of the role that social events play as determinants of pain processes requires the collection of information pertinent to a series of issues. The clear lack of isomorphism among alternative measures of pain demands a careful analysis of the ways in which pain modulating effects may be organized. SDT research, which rests upon the recognition that personal reports of pain reflect both sensory and decision-making processes represents one particular example of this type of approach. Evaluation of social influences on pain, like evaluation of the effects of other potentially pain-modulating procedures, requires an analysis of effects on psychophysical parameters based upon the subject's vocal report. An issue of equal importance for models of social effects on pain derives from the point made earlier that pain is largely inferred from behavioural observation. Since social influences operate in a milieu wherein evidence of pain is a critical determinant of the responses of others, it is of substantial interest to evaluate the effects of socially-based pain modulation procedures on behaviours that control the responses of others. While vocal report represents one such datum, also of critical interest is the nonvocal expressive behaviour of the subject. Finally, an account of the role that social events play in pain-modulation requires information regarding how such factors may operate in the natural environment.

In light of the above considerations, the following studies addressed 3 major issues. First was the issue of whether changes in expressions of pain resulting from social modeling influence procedures are reflected in

concomitant changes in sensory-discrimination capabilities, biases in favour of or against reporting the experience of pain, or both. Experiment 1 evaluated the influence of exposure to tolerant and intolerant social models on traditional and SDT measures of pain perception. In addition, Experiment 1 provided data used in an evaluation ofthe second major issue: whether social modeling influences have a more general influence, beyond the level of the discrete behaviour enacted by the model, to the overt expressive displays of the affected individual. Videotapes were taken of the behaviour of subjects undergoing the SDT task in Experiment 1. In Experiment 2 these were shown to naive observers in a SDT task requiring them to discriminate the levels of current that observed subjects were being exposed to. Experiment 3 was concerned with developing an experimental analog of the manner in which pain expressions might operate in the natural environment. Subjects displaying naturally-occurring variations in pain behaviour were exposed to one another in an adaptation of the standard modeling paradigm. This procedure allowed a partial evaluation of the relative power of pain tolerant and intolerant behaviour in a situation providing for mutual influence.

Experiment 1. Social modeling influences on pain threshold, pain tolerance and sensory-decision theory indices.

The impact of exposure to social models exhibiting relative tolerance or intolerance for painful electrical stimulation on reports of initial pain sensation (pain threshold) has been amply documented in a series of studies (Craig & Weiss, 1971, 1972; Craig, Best & Reith, 1974; Craig, Best, & Ward, 1976; Craig, Best, & Best, 1978; Craig & Niedermayer, 1974). These procedures also have an impact at supra-pain threshold levels. This has been demonstrated in studies where subjects were requested to continue accepting currents up to the point at which they preferred to quit (Craig, 1978; Craig & Best, 1977). Neufeld and Davidson (1971) and Chaves and Barber (1974) have reported similar effects using different pain-induction techniques. The effects of social modeling procedures on the response to noxious stimulation have been substantial. Consistent with current trends in pain research, however, recent interest has been focussed upon evaluation of social modeling effects via SDT methodology.

In 3 studies that have employed SDT methods, evidence has been consistent with the position that exposure to tolerant and intolerant social models produces alterations in sensory-discriminative aspects of response to noxious stimulation. Craig and Coren (1975) exposed male undergraduates to tolerant or intolerant social models while they judged ascending series of electric currents which were terminated at first report of pain. Following this, 5 stimuli were selected from the range of currents administered to each subject during the training series and were presented 12 times each in a random order. Analyses of the ratings obtained via SDT techniques indicated that exposure to an intolerant model was associated with enhanced

ability to discriminate between the various stimulus levels while tolerant modeling had no impact on the discriminability measure employed.

Stimuli administered to subjects in this study were based upon proportions of the maximum currents administered during the training series, and subjects only rated currents up to pain threshold during these series. Consequently, the impact of the modeling conditions on SDT parameters measured at clearly noxious levels of stimulation could not be assessed. A later study employed SDT methodology to investigate responses to suprathreshold levels of stimulation (Craig & Ward, Note 2). Male undergraduates rated electric currents in ascending series on a scale anchored at "undetectable" and "very painful", in 2 sessions. During the ascending series, subjects were exposed to a co-participant who was either inactive (i.e., neither rated nor received shocks) or active and tolerant (i.e., ostensibly both received and rated shocks). An SDT series was then administered, consisting of 10 random presentations of each of 10 stimulus levels, selected from various proportions of maximum currents accepted during the ascending series. Results indicated that exposure to a tolerant model was associated with reduced ability to discriminate between the various stimuli employed.

These studies have been criticized on several grounds. First, although it is standard practice to administer individualized stimulus levels in SDT pain studies, the manner in which stimuli were individualized in these studies confounded stimulus intensities with groups (Hall, 1977). In the study by Craig and Coren (1975) subjects exposed to an intolerant model accepted lower currents and subjects exposed to a tolerant model accepted higher currents than did controls. Thus, stimulus levels employed during the SDT series were lower in absolute value and differences between

adjacent pairs were smaller for intolerants than controls, while absolute values and pair differences were higher for tolerants. The same problem held in the Craig and Ward (Note 2) study. On the one hand, it can be argued that this confound resulted in a conservative test of the hypotheses since intolerant subjects in the Craig and Coren study showed enhanced discrimination in spite of the fact that differences between the stimuli they received were small relative to those in the other groups. Similarly, in the Craig and Ward study, tolerant subjects showed reduced ability to discriminate the stimuli, while the differences between levels administered to them were large, relative to subjects in control conditions. On the other hand, Weber's law would predict enhanced discrimination between stimulus pairs at low intensities and reduced discrimination at higher intensities. If Weber's law holds for the levels of stimulation employed in these studies, the findings might be accounted for on this basis alone.

These studies have also been criticized on the ground that too few stimuli were presented at each intensity to allow reliable estimation of the SDT parameters (Rollman, 1977). Lloyd and Appel (1976), following McNicol (1972) have argued that SDT pain studies should include at least 50 presentations of each stimulus intensity.

A third area of ambiguity in the Craig and Ward study pertains to the attempt to draw conclusions about the influence of tolerant modeling procedures on the discriminability of supra-pain-threshold stimulus levels. Despite the use of suprathreshold stimulus levels, the mode of data-reduction employed in this study involved the calculation of an overall index by taking the mean of all discrimination measures calculated for each subject. It could not be determined, therefore, whether the reduced

discrimination ability observed among subjects exposed to a tolerant model reflected reduced discriminability of the more intense shock pairs, the less intense pairs, or both.

A study by Craig and Prkachin (1978) overcame the group/stimulus level confounding by administering standard current intensities to a tolerant modeling group and a no modeling control group. Subjects in the tolerant group exhibited lower overall ability to discriminate the currents, as in the Craig and Ward study. However, since standard stimulus intensities were employed, some of the stimuli may have been well beyond noxious levels for some subjects, but not for others. If valid inferences are to be drawn about pain sensitivity, it would seem preferable to ensure that some of the stimulus intensities employed have at some time been described by the subject as noxious. Other problems with this study include the fact that no attempt was made to determine whether d' was reduced at all, or only some pairs of stimulus intensities. Thus, it is unknown whether the findings reflected an overall reduction in the discriminability of currents, or only a reduction at noxious or non-noxious intensities.

The present study was designed to overcome some of the criticisms applied to previous SDT analyses of the effects of social modeling procedures on pain. To ensure that the data obtained would reflect responses both to noxious and non-noxious intensities, stimuli employed in the SDT procedure were selected from 3 levels defined by the subject's behaviour during an uninfluenced preassessment session. These were: (1) around detection threshold, (2) just below pain threshold, and (3) midway between pain threshold and pain tolerance. Determination of the locus, along the shock intensity dimension, of any effect of the social influence condition on

discriminability was to be evaluated by comparing groups at each stimulus pair. Including an uninfluenced preassessment session also allowed random assignment of subjects to one of 3 social influence groups, thus avoiding the problem of group/stimulus intensity confounding. Further, Lloyd and Appel's (1976) recommendation that at least 50 presentations of each stimulus intensity be employed was adopted.

The task employed in the SDT portion of the present study required subjects to rate each stimulus on a 7-point scale of pain intensity. A concurrent forced-choice rating was also employed. At each overall level of intensity (detection threshold, sub-pain-threshold, supra-pain-threshold), 2 stimuli were presented, differing by 0.25 milliamperes (mA). The forced-choice task required subjects to identify whether the higher member of the pair was the first or the second to be presented. Previous research employing thermal nociceptive stimulation has indicated that different SDT procedures are not equivalent, in that indices of discriminability ($\underline{d}'$) based on rating scale tasks are less reliable than those based on 2-alternative, binary decision tasks (Clark & Dillon, 1973; Clark & Mehl, 1973). The forced-choice procedure was included in this study as an alternative means of assessing stimulus discriminability.

The design of the experiment called for an initial assessment of pain threshold and tolerance in the absence of social influence. In a subsequent influence session, subjects were exposed to tolerant modeling, intolerant modeling, or control procedures, followed by assessment of the impact of the procedures on SDT parameters. Various alternatives were available in the choice of rating tasks. Categorical judgment procedures are most appropriate in SDT tasks since subjects tend to use them consistently, and under

favourable conditions they allow the estimation of sensory sensitivity at several points (criteria) along the rating scale. However, a number of considerations suggested that magnitude estimation would be a more appropriate procedure to employ during the presentation of the ascending series occurring prior to the SDT task. First, magnitude estimation procedures provide reliable and sensitive measures of changes in experimentally-induced pain and are particularly suited for paradigms that involve continuous increases in stimulus intensity (Grossberg & Grant, 1976; Hilgard, 1967, 1969; Craig, Best, & Ward, 1975). Second, they can be adapted in a manner that allows the subject to report the occurrence of discrete points along the pain continuum while generating proportionate ratings of the magnitude of induced pain. For example, Hilgard, Ruch, Lange, Lenox, Morgan, and Sachs (1974) used an open-ended scaling procedure that required subjects to continuously assign numerical ratings to the sensations induced by cold-pressor pain up to the point at which they terminated the procedure. Instructions in the use of the scale required subjects to reserve a rating of "10" for that point at which they would like to stop the procedure; however, they were encouraged to perservere beyond this point while continuing to make proportionate ratings. Third, recent experience in this laboratory has suggested that magnitude estimation procedures are particularly sensitive to the effects of variations in social influence procedures. (Craig, 1978).

Method

Subjects. Subjects were 36 female undergraduate volunteers recruited from introductory Psychology courses at the University of British Columbia (M age=18.6S.D.=1.1). Subjects were contacted by telephone and offered $4.00

for participation in an experiment on perception that would involve attending two sessions. Of those who arrived at the laboratory for Session 1, four refused to participate when the experiment had been described to them, while one was excused on medical grounds. Upon being contacted to arrange Session 2, 8 more indicated their unwillingness to return for a second session. Following their participation in Session 1, subjects were randomly assigned to one of three experimental conditions for Session 2.

Apparatus and Experimental Environment

Electric currents of 0.5 sec. duration were controlled by a Hunter Decade Interval timer and delivered through concentric annular electrodes (Tursky, Watson, and O'Connell, 1965) via a 60 Hz controlled-current electrostimulator (Lafayette Instrument Co., Model A-6158). Videotape recordings were made on half-inch videotape, using a Sony Model AV-3400 videocorder and camera.

The experimental room contained the stimulation equipment, and two chairs. Subjects were seated beside a wooden partition which, in Session 2, visually isolated the subject and the model. A wooden partition also visually isolated the subject from the experimenter and the control equipment. The videotape camera was situated approximately 2 meters in front of the subject and in full view. In order to indicate stimulus occurrences on the videotapes, a 1 cm. diameter jewel light was located behind and slightly to the left of the subject's head and was controlled by the timing equipment to illuminate concurrently with stimulus presentation and remain on for a duration of 5 sec. A wooden partition was located at right angles to the partition isolating the subject from the experimenter. To the right of this partition, isolated from the subject's view, was a 1 cm. jewel

light. During both sessions, sheets of paper that depicted the rating scales were affixed to the partition blocking the subject's view of the experimenter. Subjects were seated in the same chair in both sessions. Including a second person, the model, in Session 2 required that she be seated to the subject's right so that the "dummy" electrode could be attached to her.

Procedure. Session 1

Subjects were greeted at the laboratory by the experimenter, who indicated that another subject would be coming and then the experiment would be under way. The purpose of this ruse was to avoid arousing suspicions at the introduction of an ostensible co-participant in Session 2. After a few minutes' conversation with the subject, the experimenter stated, "As long as we're waiting, I might as well get you started by giving you a couple of questionnaires to work on." Subjects then completed the S-R Inventory of General Trait Anxiety (Endler and Okada, 1975) and the Subjective Stress Scale (SSS; Neufeld and Davidson, 1972). While subjects were completing the questionnaires, the experimenter completed preparation, of the equipment, and made a couple of forays to the door to look for the "other subject." When the subject had completed the questionnaires, the experimenter suggested that the experiment should proceed without the other subject. The experiment was then described as a study in "the perception of discomfort resulting from mild electrical stimulation." The procedures and stimulation were described, and the subject was given the opportunity to withdraw. When consent had been obtained, the subject was seated in the experimental room and the following instructions were read:

> I'm going to present you with a series of low currents that will start at undetectable levels and will gradually increase in intensity and discomfort. Your task will be to indicate how

> uncomfortable each momentary current feels by assigning it a number ranging from zero up to 10, and then beyond. Initially, the current will be so low that you will probably feel nothing. If this is the case, the rating "zero", for "undetectable", is appropriate. Thereafter, they will gradually increase in intensity and discomfort. We would like you to rate each subsequent shock in proportion to the amount of discomfort that you feel, so that, for example, if on one current you give a rating of "2", and then a later one feels twice as uncomfortable, you give the later one a rating of "4". (These ratio instructions were based on those employed by Craig & Prkachin, 1978, and Craig, 1978a). Higher ratings should reflect increases in physical discomfort. You will eventually reach a level of current that you would describe as giving you a sensation of "very faint pain." We would like you to give that current a rating of "10" and then we'd like you to continue accepting currents for as long as possible after you've reached this level. When you reach the point where you don't wish to accept any further stimuli, give that current your final rating, call out the word "terminate" and no more will be given to you.

After the subject had indicated her understanding of the instructions, the experimenter stated, "We like to videotape each session so that I can check on the accuracy of my recordings," and the videotape camera was then focussed on her.

Redux paste was then applied to the subject's left forearm, and the electrode positioned as necessary to reduce the resistance in the electrode-skin circuit to 5000 ohms (Tursky _et al_., 1965). Subjects then underwent two ascending series of the psychophysical method of limits with current levels starting at 0.0 mA and increasing in 0.5 mA steps until a "terminate" rating was given. Inter-stimulus intervals were 10 sec. Video recordings were taken continuously throughout both series. At the end of the second series, subjects completed the SSS and the adjective checklist portion of the McGill Pain Questionnaire (MPQ; Melzack & Torgerson, 1971) with instructions to rate the highest shock accepted. Subjects were then dismissed with instructions not to talk about the experiment.

Session 2

Subjects returned for Session 2 a mean of 15.3 days (S.D.=12.4) after Session 1. The model typically arrived several minutes later than the subject. Four females, aged 20, 21, 21, and 28 served as models. The model was always treated as if she were a naive subject. When both had arrived, subject and model were introduced and given the SSS to fill out. They were then escorted to the experimental room, seated in their appropriate chairs, and had the following instructions read to them:

> The first part of what we will do today is going to be identical to what occurred during the first session. Let me review things briefly to refresh your memory. I will again present you with a series of low currents starting at undetectable levels that will gradually increase in intensity. As before, I would like you to rate them on the 0 to 10 scale with 0 standing for undetectable, 10 standing for very faint pain, and so on. As before, make your ratings in proportion to the amount of discomfort that you feel. When you reach the point where you don't wish to accept any further stimuli, give that current your final rating, call out the word "terminate", and no more will be given to you.

Electrodes were then attached to both subject and model. Immediately before commencing shock administration, the experimenter instructed the subject that she should give her rating first, followed by the model. Subjects then went through 3 series of electric shocks, each increasing in 0.5 mA steps from 0.0 mA until they gave their "terminate" rating, or until a maximum current of 18.0 mA had been accepted.

During this session, subjects were exposed to one of 3 experimental treatments. Those assigned to the tolerant (T) group made their ratings concurrently with a model who consistently assigned ratings to the shocks that were 25% lower than those of the subject. When the subject had given her "terminate" rating, the experimenter informed her that no more shocks

would be given to her, but shocks would continue for the model. On the following trial, the model gave the same rating she had given on the subject's "terminate" trial. On the next two trials, the model gave ratings increasing by one rating-scale unit and then gave her "terminate" rating. These contingencies did not, of course, apply when subjects had taken currents up to the maximum of 18.0 mA.

In the intolerant (I) condition, subjects were exposed to a model who consistently rated the shocks to be 25% higher than did the subject. Further contingencies for the role required that the model rate the first current at "0" and the second at "1). When the subject gave her first rating above "10", the model gave her corresponding rating, and then gave a "terminate" rating. The model was then informed that no more shocks would be given to her, and the series proceeded until the subject gave a "terminate" rating.

In the control (C) condition, following reading of the preliminary instructions, the experimenter stated that for the first part of the experiment, only the subject would be receiving shocks and should respond.

Videotape recordings were made of subjects during all 3 ascending series in Session 2.

SDT Series

Following completion of the 3 ascending series, a second phase of the experiment, concerned with SDT analyses, began. In this phase, subjects were exposed to a series of pairs of shocks that had been selected on the basis of the subject's performance during the second ascending series of Session 1. The first pair consisted of that current first reported as detectable during the second ascending series of Session 1 (i.e., the first nonzero rating), and a current level 0.25 mA lower. The second pair

consisted of the current level rated as "8" and that level minus 0.25 mA. When no "8" rating had occurred, the closest rating lower than "8" and that level minus 0.25 mA were used. The third pair consisted of the current level corresponding to the rating occurring halfway between "10" and "terminate", and that level minus 0.25 mA.

Prior to initiating the SDT series, the following set of instructions was read:

> The next part of the experiment is going to be quite a bit different. In this part, I'm going to present you with a series of pairs of currents that will occur in random order. Each pair will occur very quickly. In this part your task will be a little bit more complicated. Instead of rating the currents on the 0 to 10 and above scale that you've been using, we would like you to rate each current using the categories that I am going to put up on these sheets.

The experimenter than replaced the sheets containing the representation of the 0 - 10 scale with sheets that depicted a 7-point categorical judgment scale consisting of the following descriptors and rating scale numbers: 0 -- Undetectable, 1 -- Faint Sensation, 2 -- Pre-Pain Sensation, 3 -- Very Faint Pain, 4 -- Mild Pain, 5 -- Moderate Pain, 6 -- Strong Pain. This scale was based on that used by Chapman and his associates (Chapman, Gehrig, & Wilson, 1975), but modified to allow for shock induced sensations below pain threshold. The instructions then continued as follows:

> Indicate your choice by assigning each current a number corresponding to a category on the sheet. Take a close look at the categories for we want you to learn which number goes with which label as soon as you can. Notice that undetectable is still given a rating of 0 just like it was on the old scale. However, very faint pain, which was on the old scale was 10, is now to be given a rating of 3. One would be used to indicate that you can <u>just</u> detect the shock, while 2 indicates that you can definitely feel the shock but it is not yet painful.

> I will also ask you to make a second type of rating. As I said, I am going to present the stimuli to you in pairs. After you have rated both stimuli on the 0 - 6 scale, I would like you to tell me whether you think that the higher, or the more intense stimulus of the pair was the first one to be presented or the second. Indicate your choice by calling out the words "first" or "second."

At this point, subjects were also informed that none of the currents to be administered would be any higher than they had accepted in the past. The experimenter then insured that the subject understood the task. One hundred sixty-two stimulus pairs, balanced equally for low, medium, and high pairs (i.e., there were 54 presentations of each pair) were then presented in a random order, subject to the condition described below in the grouping of trials into blocks. Stimulus pairs were also balanced equally in terms of whether the first or the second of the pair was higher. Thus, the prior probabilities of occurrence of low, medium, and high pairs were equal at .33 as were prior probabilities for the binary discrimination (.50). The entire SDT series was broken down into 3 blocks of 54 stimulus pairs. Within each block was included 3 series of 18 stimulus pairs, balanced equally for current magnitude (i.e., 6 presentations each of low, medium and high pairs.) and for whether the first or second stimulus of each pair was higher. Within each block, the order of presentation of each series was randomized on a subject-by-subject basis. Videotaping of subjects during the SDT series occurred on the first series of Block 1, the second series of Block 2, and the third series of Block 3. Thus, videotapes of 1/3 of stimulus presentations in the SDT series occurred, and corresponded to the first, fifth, and ninth series of 18 stimulus pairs. Upon completion of the first and second block of 54 trials, a One-minute rest period occurred.

To maintain the modeling influence for experimental groups during the SDT series, the model remained active throughout. The model's role during this series differed slightly from that in the ascending series. In conditions T and I, the model made discrepant ratings in the appropriate direction on 39 trials (roughly 24% of all trials). In condition T, the model made discrepant ratings one scale point below the subject's ratings on these trials, while in condition I, the model made discrepant ratings one scale point higher. To enhance the credibility of the model's behaviour, she also made discrepant forced-choice ratings on 30 (roughly 19% of) all trials. Discrepant category scale and binary-choice ratings were independent of one another. Discrepant ratings occurred randomly throughout the SDT series. When the model was not specifically signalled to perform a discrepant rating, she gave ratings that were identical to those of the subject. In circumstances where giving a discrepant forced-choice rating was illogical (e.g., when the subject had given a rating of "3-4" and rated the second stimulus as higher, which would ordinarily have called for the model to emit the illogical rating "3-4, first higher") the model gave ratings that were identical to those of the subject.

In condition C, the model's presence as an active co-participant was brought about by the experimenter informing subject and model that, during the SDT series, the model would be receiving shocks, but, unlike the model, should write her ratings on a mimeographed sheet rather than verbalizing them aloud. The experimenter then gave the model a clipboard, sheet and pencil and spent some time ostensibly instructing her in how to write her ratings. Prior to initiating the SDT series, the experimenter cautioned the model to read the instructions at the top of the sheet carefully and

understand them thoroughly before the series started.

Inter-pair intervals during the SDT series varied from 10 - 20 sec., while the spacing between stimuli in each pair was roughly 1 - 2 sec.

When the SDT series had been completed, subject and model were escorted to the adjoining room where they completed the SSS and the MPQ.

When subjects had finished completing the questionnaires, the nature of the deception was revealed to them, and they were fully debriefed as to the background and purposes of the experiment. The intent to use the videotapes taken of them in later research was explained, and they signed consent forms indicating that they were agreeable to this. (The consent form employed is presented in Appendix B.) Following this, subjects were paid, and requested not to talk to anyone in their classes about the experiment for a period of about a month.

Results

Subject attrition

During the course of the study, 8 of the 44 subjects who completed Session 1 indicated their unwillingness to return for a second Session. Of the 38 subjects who returned for Session 2, 7 terminated the session during the signal detection series. Of these, 5 were in group I, 1 was in group T, and 1 was in group C. All were subjects who accepted currents of lower intensity during Session 2 than during Session 1.

Verbal reports of pain threshold and pain tolerance

It was of concern to evaluate whether the greater rate of attrition of subjects in group I during Session 2 and the subsequent replacement of these subjects resulted in attrition of subjects exhibiting different initial pain threshold (first rating of 10 or greater) or pain tolerance (maximum current accepted) values. Accordingly, analyses of variance (ANOVAs) were performed on pretest threshold and tolerance values during the two ascending series of Session 1. The first pair of analyses included data from all subjects who completed the 3 ascending series of Session 2 (i.e., including those who dropped out during the SDT series) and is based on sample sizes of 11 in group T, 15 in group I, and 10 in group C. The analysis performed on the current intesity provoking an initial rating of 10 or greater (i.e., threshold) revealed no significant between group differences, $\underline{F}$ (2,33) = 0.94, p >.05. The analysis on the current intensity for pain tolerance revealed no significant between groups, $\underline{F}$ (2,33) = 2.12, p > .05, or Series, $\underline{F}$ (1,33) = 2.16, p > .05, effects. Thus, there

were no differences between groups on these measures at the end of Session 1 that were statistically reliable.

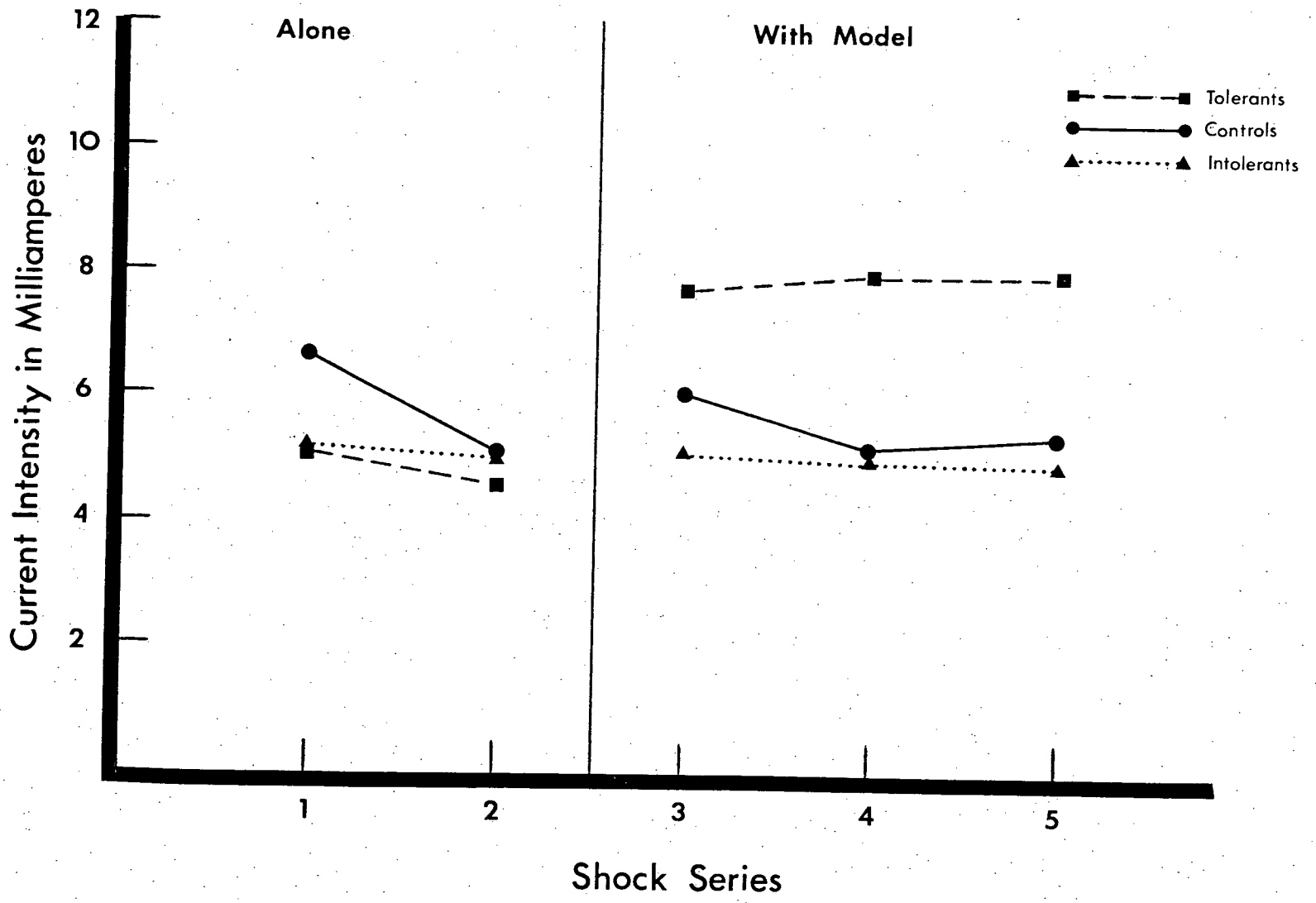
The same analyses were performed excluding the data from those subjects who dropped out during the signal detection series. The threshold analysis resulted in no significant between-group effects, F (2.27) = 1.65, $p > .05$. The analysis of pain tolerance with dropouts excluded resulted in a between groups effect that approached, but did not attain, conventional levels of statistical reliability, F (2,27) = 2.79, p =.08, and no other noteworthy terms. Overall, therefore, it was reasonable to conclude that the groups were comparable in terms of pain threshold and pain tolerance values prior to undergoing the influence conditions of Session 2.

Threshold and tolerance data were examined further in order to determine effects of exposure to the social influence conditions. The plan of analysis proceeded as follows. First, the data were analyzed in a 3 (Groups) X 5 (Shock Series) ANOVA design with repeated measures on the Series factor. Following this, simple main effects were evaluated for statistical reliability. Finally, a series of planned orthogonal comparisons was conducted within each group, across the Series dimension. Between group comparisons were conducted using Dunnett's test for comparing treated groups with a control group. Further *a posteriori* comparisons were conducted as necessary using Tukey's *HSD* procedure (Kirk, 1968). In the overall analysis, levels 1 and 2 of the Series variable represented performance during the pretesting session, and levels 3 to 5 represented performance under the social influence conditions of Session 2. Data from all subjects who completed the ascending series of Session 2 were included. The ANOVA for threshold data resulted in significant effects for the Series variable,

F, (4,132) = 3.76, p <.01, and for the Series X groups interaction, F (8,132) = 4.61, p <.01. Figure 1 portrays mean threshold values for all three groups across the 5 shock series. Analyses of simple effects for differences between groups at each level of the Series variable, employing the pooled error term suggested by Kirk (1968), revealed no systematic between group differences (α = .05) at Series 1 and 2, F (2,165) = 1.41 and 0.17, respectively -- whereas significant between group effects occurred at all series during the influence session, F (2,165) = 3.48, 5.14, 5.20 for Series 3 through 5, respectively.

Further analyses on these significant effects were performed, employing Dunnett's test for comparisons of experimental groups with a control group. Results of this analysis showed that subjects in group I did not differ from control subjects in mean pain threshold at any of the shock series during the influence session. Subjects exposed to a tolerant model, however, exhibited significantly elevated mean pain threshold values relative to control subjects on shock series 4 and 5 (Dunnett's test critical value = 2.29; differences between group T means and group C means at series 4 and 5 = 2.75 and 2.55, respectively). Mean pain threshold values for subjects in group T at series 4 and 5 were 7.95 mA (S.D. = 4.17) and 7.95 mA (S.D. = 3.97). For group C the corresponding values were 5.20 mA (S.D. = 1.58) and 5.40 mA (S.D. = 1.26). Further post-hoc analyses with Tukey's HSD procedure revealed that the significant between groups effect during series 3 occurred between groups T and I (Tukey's HSD critical value (α = .05) = 2.53; group T group I difference = 2.58 mA). Means for groups T and I at this level were 7.68 mA (S.D. =3.60) and 5.10 (S.D. = 1.93), respectively. Planned orthogonal comparisons were

Figure 1: 1. Mean intensity of current provoking a rating of "10" (pain threshold) under uninfluenced (Alone) and influenced (With Model) conditions for subjects in Groups T, C, and I.


Alone
With Model
Tolerants
Controls
Intolerants
Current Intensity in Milliamperes
12
10
8
6
4
2
1
2
3
4
5
Shock Series

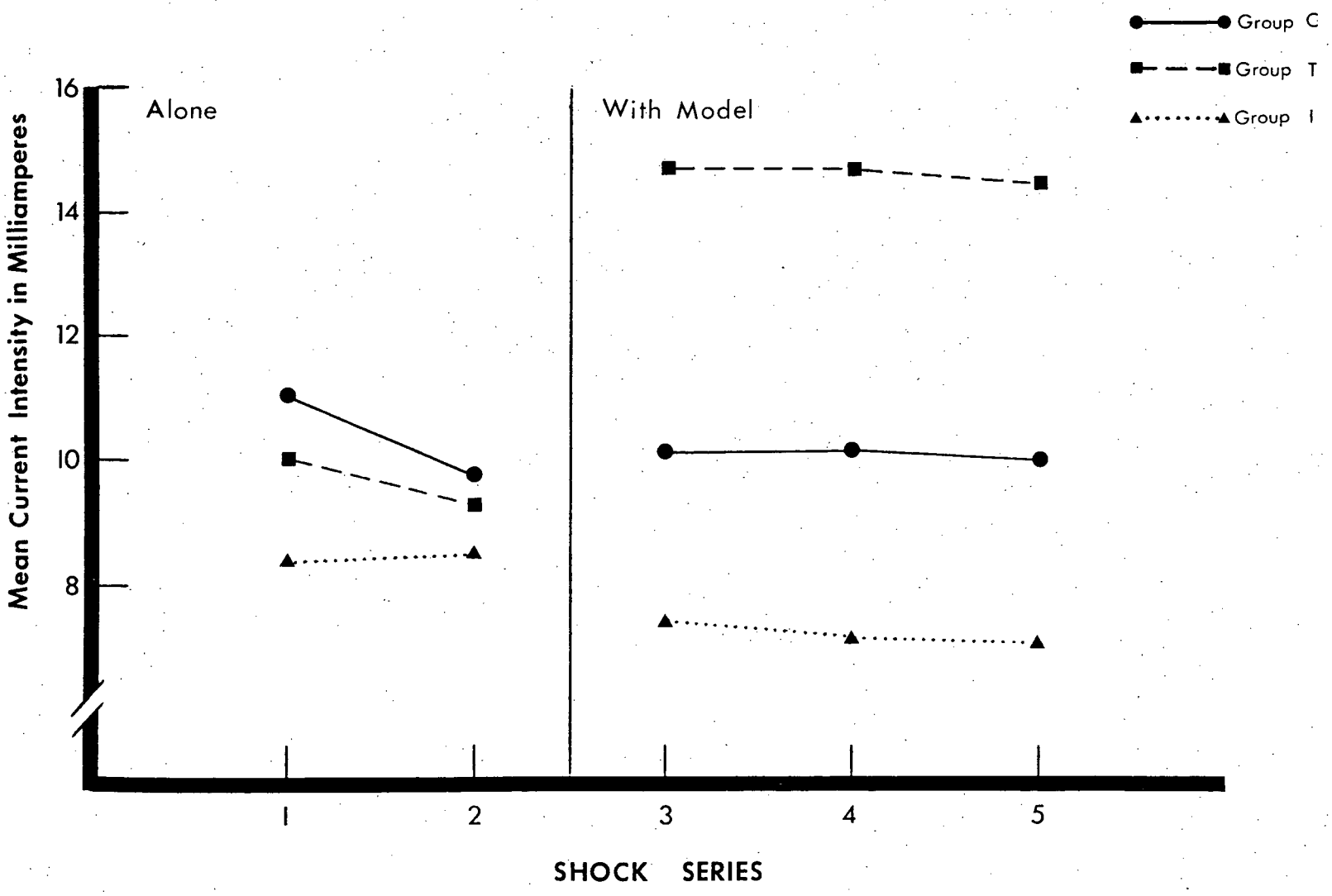
conducted along the Series variable at each level of the groups variable. The critical contrast examined was that between the first two (pretest) and the remaining three (influence session) shock series. These analyses revealed a significant pretest to influence session change among subjects in group T only; t (132) = 6.51, p <.01. Pain threshold values increased among subjects exposed to a tolerant model from a mean of 4.85 mA in the pretest session (S.D. = 2.09) to a mean of 7.86 mA in the influence session (S.D. = 3.91). A similar picture emerges if only those subjects who completed the SDT series are included in the analysis. The overall analysis resulted in a significant effect for Shock Series, F (4,108) = 6.02, p <.01. Since it was the SeriesXGroups effect that was of critical interest, further analyses were conducted on the simple effects contributing to this term. These analyses revealed significant between-group differences at levels 3, 4, and 5 of the series variable, Fs(2,135) = 4.26 (p < .05), 5.52 (p < .01), and 5.40 (p < .01). The between groups effects reflected significant differences between groups T and I at Series 3, 4, and 5, and between groups T and C at Series 4 and 5 (Tukey's and Dunnett's tests). Within group analyses resulted in significant effects only across series within group T, F (4,108) = 13.12, p < .01. The significant Series effect within group T reflected an increase in pain threshold between pretest and influence sessions, t (108)= -7.18, p < .01.

Pain tolerance data were subjected to similar analyses. The overall analysis including all subjects who completed the ascending series of both sessions resulted in significant effects for Groups, F(2,33) = 10.98, p <.01, Series, F(4,132) = 3.65, p <.01, and the Groups X Series interaction, F(8,132) = 9.34, p <.01. Analyses of simple effects revealed

significant between-groups differences at levels 3, 4, and 5 of the Series variable, $Fs(2,165) = 16.09$, 17.12, and 16.33, all $ps < .01$. Comparisons of experimental groups with the control group by Dunnett's test revealed that on all 3 influence session series, group T differed significantly ($\alpha = .05$) from group C (Dunnett's critical value = 2.96; T-C differences = 4.53, 4.53, and 4.40 mA for series 3, 4 and 5). Group I differed significantly from group C on series 4 (C-I difference = 2.97 mA) and there was a trend in the same direction on trial 5 (difference = 2.92 mA). Orthogonal t-tests contrasting pretest with influence session tolerance values for all 3 groups resulted in significant effects within group T, $t(132) = 8.69$, $p < .01$, and group I, $t(132) = 2.46$, $p < .05$ (both tests 2-tailed). These terms reflected significant increases in tolerance among group T subjects (M session 1 = 9.69 mA, S.D. = 2.39; M session 2 = 14.64 mA, S.D. = 4.19) and decreases among group I subjects (M session 1 = 8.48, S.D. = 2.92; M session 2 = 7.28 mA, S.D. = 2.99). The control group remained stable (M session 1 = 10.43 mA, S.D. = 2.70; M session 2 = 10.15 mA, S.D. = 3.43). These data are depicted in Figure 1:2.

The results for pain tolerance differed somewhat if only those subjects completing the SDT series were included in the analysis. This analysis resulted in the same significant overall effects: Groups, $F(2,27) = 13.13$, $p < .01$; Series, $F(4,108) = 6.10$, $p < .01$; and Groups X Series, $F(8,108) = 8.95$, $p < .01$. Simple effects along the Series variable suggested significant between groups differences at Series 3 through 5, $Fs(2,135) = 20.02$, 17.98, 16.07, all $ps < .01$. At series 3, 4, and 5, Group T exhibited significant elevations in tolerance relative to group C, all differences exceeding the critical value for Dunnett's test ($\alpha = .05$) of

Figure 1: 2. Mean intensity of current provoking a "terminate" (pain tolerance rating under uninfluenced (Alone) and influenced (With Model) conditions for subjects in Groups T, C, and I.


Group C
Group T
Group I
Alone
With Model
Mean Current Intensity in Milliamperes
16
14
12
10
8
1
2
3
4
5
SHOCK SERIES

2.93. Subjects in group I exhibited reduced tolerance that approached, but did not attain statistical significance. Main effects of Series within groups were only significant for group T which exhibited elevations in tolerance from Session 1 (M = 10.00 mA, S.D. = 2.24) to Session 2 (M = 15.55 mA, S.D. = 3.04, t (108) = 9.60, $p < .01$.

In general, the results of analyses of the ascending series may be summarized as follows. On pain threshold, only subjects in group T exhibited significant changes from Session 1 to Session 2. This change accounted for subjects in group T exhibiting significant elevations in pain threshold during the influence session, relative to subjects in group C. On pain tolerance, when data from all subjects completing the ascending series of Session 2 were included, group T exhibited a significant pretest to influence session increase, while those in group I exhibited a significant decrease. This change resulted in an overall elevation in pain tolerance among subjects in group T, relative to those in group C, and a somewhat weaker reduction in tolerance among those in group I. When only those subjects who completed the SDT series were included in the analysis, the results were in the same direction, but the effects in group I were not statistically reliable. On both pain threshold and tolerance, subjects in group C maintained stable values from Session 1 to Session 2.

SDT DATA: Preliminary analyses

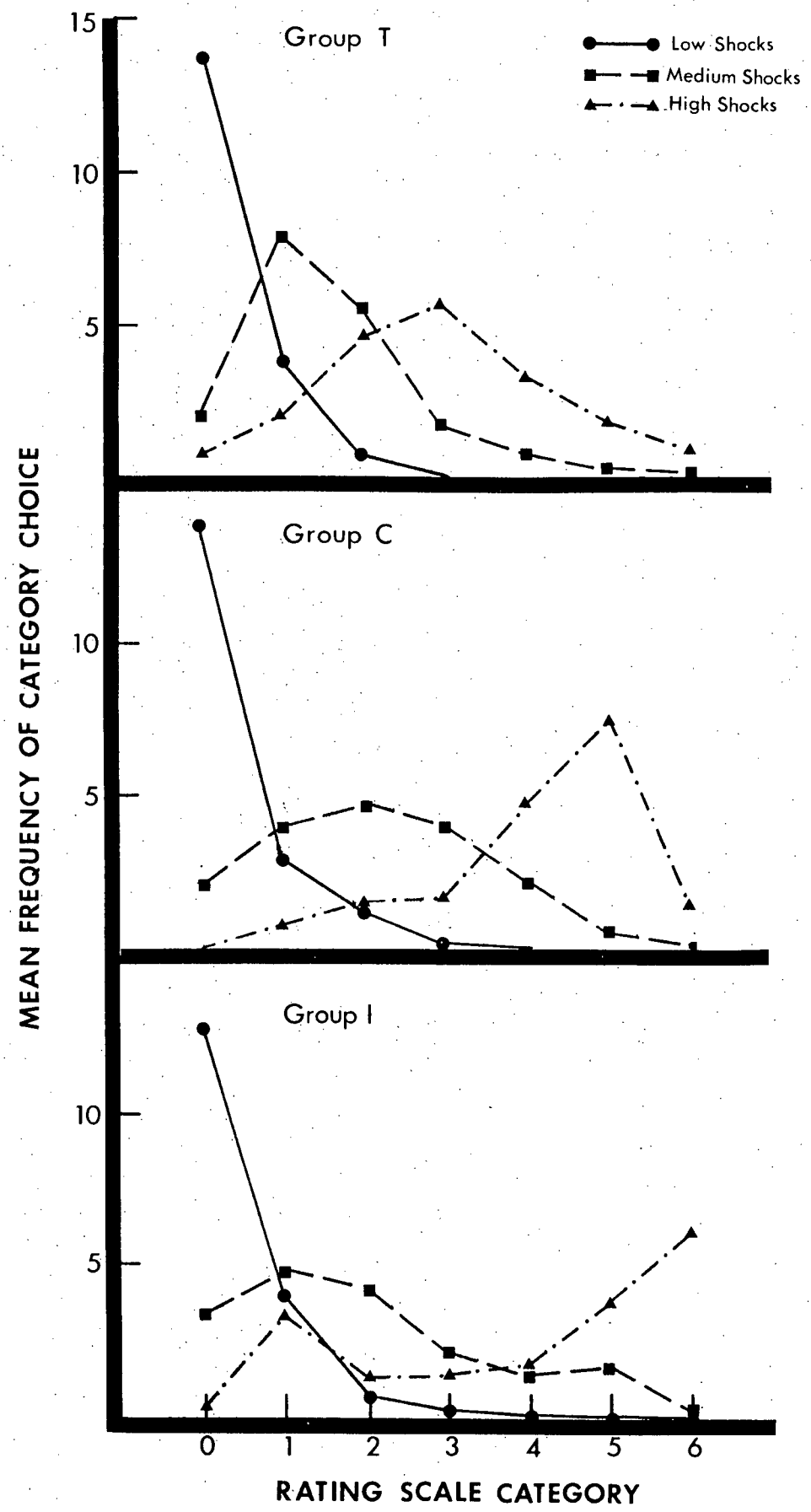
In order to determine whether the differential dropout rate among group I subjects had influenced the overall current intensities administered during the SDT series, and to check on random assignment, a 3 (groups) x 6 (Stimulus Levels) ANOVA was performed on these values. This analysis

revealed that there were no significant between-group differences in overall levels of current administered, $F(2,25) = 0.19$, $p < .05$, nor was the interaction between Groups and the 6 Stimulus levels significant, $F(10,140) = 0.85$, $p > .05$. A significant Stimulus levels effect, $F(5,140) = 220.10$, $p < .01$, merely reflected the increase in current intensities from low to high shocks. Thus, the groups were comparable with regard to the current intensities administered at all levels.

Following this, judgmental data were analyzed according to the frequencies with which subjects employed each category of the rating scale at each of the 6 stimulus intensities employed. The session was divided into three blocks of 18 trials at each stimulus intensity and this factor was included in the 3 (Groups) X 3 (Trial Blocks) X 6 (Current Intensities) X 7 (Rating Categories) ANOVA. Of sole interest in this analysis was the pattern of ratings exhibited by the 3 groups. Therefore, only those interaction terms involving Groups and Rating Categories were examined following the original ANOVA. The only significant interaction term involving both these variables was the Groups X Current Intensities X Rating Categories effect, $F(60,780) = 1.50$, $p < .01$.

This effect is depicted in Figure 1:3 where the differential pattern of category choice across groups can be observed. All 3 groups exhibited the same pattern of category choice to the lowest pair of stimuli. The modal response was at category 0 (undetectable) and all groups' frequencies of category choice declined rapidly thereafter. None of the between-group differences at this pair of stimulus intensities was significant. For the middle stimulus pair (current levels 3 and 4), all groups favoured categories 1 (faint sensation) to 3 (very faint pain). The mode for groups T and I was at category 1, whereas the mode for group C was at category 2.

Figure 1: 3. Mean frequency of choice of each rating scale point at high, medium, and low shock intensities for subjects in Groups T, C, and I. Note: Rating scale point descriptors are Undetectable (0), Faint Sensation (1), Pre-Pain Sensation (2), Very Faint Pain (3), Mild Pain (4), Moderate Pain (5), Strong Pain (6).


Group T
Low Shocks
Medium Shocks
High Shocks
Group C
Group I
15
10
5
10
5
10
5
MEAN FREQUENCY OF CATEGORY CHOICE
0
1
2
3
4
5
6
RATING SCALE CATEGORY

Frequency of choice of category 1 was significantly greater among subjects in group T than among those in groups I and C by Tukey's HSD procedure (critical value , α = .05 = 2.52; means: group T = 7.87, group I = 4.83, group C = 4.19). Subjects in group C exhibited a significantly greater frequency of choice of category 3 than did subjects in group T when judging currents from the middle stimulus pair (means: group C = 4.30, group T= 1.58). The difference between groups C and I at this category and pair of stimulus intensities was not significant (mean: group I = 2.28). For the high pair of stimulus intensities, group T's modal frequency of category choice occurred at category 3 (faint pain) whereas those for groups I and C fell at categories 6 (strong pain) and 5 (moderate pain), respectively, group T exhibited an elevated frequency of choice of categories 2 and 3 at this pair of intensities relative to groups I and C, which did not differ (means at category 2: group T = 4.50, group I = 1.37, group C = 1.52; at category 3: group T = 5.63, group I = 1.37, group C = 1.65). At category 4, group C's mean (4.80) was significantly greater than group I's (1.75), and at category 5, group C's mean (7.69) was significantly greater than both group I's (1.78) and group T's (1.75). At category 6, subjects in group I exhibited an elevated mean (6.03) relative to groups T (0.92) and C (1.50) which did not differ. Overall then, the major differences in frequency of category choice occurred at the middle and high stimulus pairs. At both stimulus intensity levels, subjects in group T selected response categories indicating less pain than did subjects in groups C and I. Differences between groups I and C only emerged at the highest stimulus pair and the response category indicative of greatest pain. Subjects in group I employed this category more frequently in describing their response to the highest stimulus pair than did subjects in groups T and C.

To summarize, it was apparent from the training series, and from preliminary analyses of data from the SDT series that group differences in pain reports resulted from exposure to the various treatments. The effects seemed most substantial in group T. Subjects in this group exhibited the most dramatic changes during the ascending series, and exhibited a greater discrepancy from Control subjects in their selection of rating-scale categories than did subjects in group I. SDT analyses were performed next in order to determine whether between-group differences in discriminability or response-bias would emerge.

SDT analyses

SDT analyses were conducted on data from the forced-choice procedure. Since sensitivity indices derived from forced-choice tasks are likely to be affected if subjects exhibit preferences for identifying a given interval as the one containing "signal" (McNicol, 1972), these data were first examined in order to determine whether such interval biases occurred and varied systematically across groups. An index of interval bias was calculated for each subject as the ratio of the number of identifications of interval 2 with "signal" to the number of identifications of interval 1 with "signal". This index has a value of 1.00 when no interval bias is present, values less than 1 when a preference is exhibited for the first interval and a value exceeding 1 when a preference is exhibited for the second interval.

Separate analyses of variance were performed on these data at each forced-choice pair (i.e., low, medium, and high). For the low, medium, and high forced-choice pairs, there was no evidence suggesting differential

preference for one interval across groups, Fs (2,26) = 0.99, 0.37, and 2.64, respectively (p >.05).

Estimates of d' calculated on data from the forced-choice task were entered in a 3 (Groups) X 3 (Pain Intensity Levels) ANOVA design. None of the effects in this analysis approached statistical significance.

For the major SDT analyses, the conditional probabilities of occurrence of a particular response category given the presentation of a particular stimulus level were calculated. These probabilities were then cumulated from the highest to the lowest response category at each stimulus level. The tables so derived were employed to estimate the SDT parameters. Initially, values of d' and L_x between adjacent stimulus pairs were calculated at all points of the rating scale where these measures were defined (i.e., where the probability of a hit, p(Hit), and the probability of a false alarm, P(FA), $\neq$ 0.00 or 1.00). For d', the mean value at each stimulus pair was then calculated. Since actual stimuls intensities administered to subjects were individualized, each of the derived mean d' values was expressed as an overall discriminability index (DI):

$DI = \frac{d'}{S_2 - S_1}$, where S_2 and S_1 refer to the values of the higher and the lower stimuli of the pair (cf. Craig & Coren, 1975).

At the lowest 2 stimulus intensity pairs, the parameters were in - calculable for 7 (23%) of subjects. Consequently, differences in mean DI were evaluated only across those stimulus intensity pairs where complete data were available (pairs 3-4 to 5-6). These data were analyzed in a 3 (Groups) X 3 (Stimulus Pairs) factorial design. Results of this analysis indicated no significant between-groups, $F(2,27) = 0.65$, $p > .05$, or Stimulus Intensity, F (2,54) = 1.16, p>.05, effects. However, the Groups X Stimulus

Pairs interaction term was statistically significant, $F(4,54) = 3\ 86, p < .01$. Mean DIs for these stimulus pairs are presented in Table 1: 1. Between-group differences within each stimulus intensity pair were further evaluated by Dunnett's procedure.

Table 1:1

Mean Discriminability Indices at Stimulus Pairs 3-4 to 5-6 for Tolerant, Intolerant, and Control Subjects

Group	Stimulus Pair 3-4	4-5	5-6
Tolerant	1.36	0.77	1 .15
Control	0.64	0.81	0.67
Intolerant	0.39	1.71	0.84

Note: Higher values for the discriminability index indicate greater discriminability.

This analysis indicated that DI values for both groups T and I were not significantly different from those for group C at stimulus pairs, 3-4 and 5-6. However, at stimulus pair 4-5 group I exhibited increased DI values relative to group C (Dunnett's critical value, (α=.05) = 0.80; group I - group C difference = .90). Group T's mean DI value did not differ from that for group C at any stimulus pair. Thus, at this stimulus pair, discriminability was increased among I subjects relative to those in groups C and T who exhibited comparable levels of discrimination.

Values of the likelihood-ratio criterion, $\underline{L}_x$, were examined in order to determine whether the social influence conditions were differentially associated with biases toward reporting greater or lesser pain. A variety of different strategies are available for examining bias effect. After Clark (1974), mean values of $\underline{L}_x$ were calculated across all stimulus levels at the "very faint pain" rating category (L_{VFP}). This value was then analyzed in a one-way analysis of variance. Results of this analysis revealed no significant between-group differences, $\underline{F}(2,20) = 1.66, p > .05$. However, data from 8 subjects (27%) had to be excluded because the parameter was incalculable at this criterion. A second strategy was to calculate the overall mean $\underline{L}_x$ value across all rating scale categories at all pairs of stimulus intensities. Again, since many of these parameters were incalculable at the lowest 2 pairs of stimulus intensities, variation in mean $\underline{L}_x$ was assessed across stimulus levels 3-4, 4-5, and 5-6. Results of the analysis of variance again indicated no significant between-groups, $\underline{F}(2,27) = 0.64$, $p > .05$, or Groups X Stimulus Pairs, $\underline{F}(4,54) = 0.74, p > .05$ effects. The effect of stimulus-pair levels on mean $\underline{L}_x$ was significant $F(2,54) = 3.13$, $\underline{p} = > .05$, and indicated a trend for subjects to adopt

more stringent criteria for reporting pain at stimulus pair 4-5 than at pairs 3-4 and 5-6 (Ms = 1.01, 1.69, and 1.02 for levels 3-4, 4-5, and 5-6, respectively). This trend may simply be an artifact of the fact that at level 4-5 there were fewer points at which estimates of $\underline{L}_x$ were calculable.

Because of the problems presented by incalculable parameters in the above standard analyses, a second set of analyses was conducted, employing nonparametric measures of the SDT parameters. The discriminability of pairs of stimulus intensities was investigated by estimating the area under the receiver-operating-characteristic (ROC) curve. In instances where only one or two points were available for plotting the path of the curve, the measure $P(\overline{A})$ (McNicol, 1972; Pollack, Norman, & Calanter, 1964) was employed as the best estimate of the area under the curve. This measure involves plotting the point (p(FA), p(Hit)), and projecting two lines through it: one from the origin through the point and one from the intersection of p(FA) = 1.0 and p(Hit) = 1.0 through the estimated point in the opposite direction. When only one pair of hit and false alarm categories is available, this procedure will divide the ROC plot into 4 separate areas: 2 triangles formed by the lines intersecting at the point corresponding to the plotted hit and false alarm probabilities, an upper and a lower quandrangle. Assuming iso-sensitivity at all response criteria, the area bounded by the lower quadrangle (W) represents performance that is worse than that indicated by the obtained hit and false alarm probabilities, while the area bounded by the upper quadrangle (B) represents superior performance. The 2 triangles (U_1, U_2) delimit an area of uncertainty within which the subject's performance must fall. $P(\overline{A})$ was obtained by adding half of this area of uncertainty to the area representing inferior performance. The same procedures were employed when more than one point was available for plotting the ROC curve. When more than 2

points are available, the area of uncertainty becomes exceedingly small, and the value of $P(\overline{A})$ closely approximates the value that would be obtained by directly measuring the area under the curve, P(A). When 3 or more points were available for plotting the ROC curve, this latter measure was employed.

An initial analysis was conducted on these values of P(A) corrected for the differences in stimulus intensity upon which they were based by the following formula:

$$P(A) \text{ standardized} = \frac{P(A)}{S_2 - S_1} .$$

The overall analysis suggested that there was no significant between-groups effect, $\underline{F}(2,27) = 0.18$, $\underline{p} > .10$. The Groups x Stimulus Pairs interaction approached, but did not attain conventional levels of statistical significance, $\underline{F}(8,108) = 1.74$, $\underline{p} > .10$. Interestingly enough, however, the greatest differences between means in the interaction term occurred at level 4-5, the same stimulus pair where significant between-group differences emerged when the parametric D1 measure was employed. When evaluated by Dunnett's test employing the critical value associated with a one-tailed α of .05, the difference between groups I and C was significant, with group I subjects exhibiting enhanced discriminability relative to group C subjects.

A nonparametric measure of response-bias -- $\underline{B}$ (McNicol, 1972) -- was calculated for each subject. This parameter is an estimate of the point along the rating scale where a subject is equally disposed toward giving "signal" and "noise" responses. It is calculated by determining the rating scale point at which the sum of p(FA) and p(Hit) is equal to 1.0. In instances where one rating scale point is associated with a p(FA) + p(Hit) value exceeding 1.0 and an adjacent scale point is associated with a p(FA) + p(Hit) value of less than 1.0, the value of $\underline{B}$ is obtained by extrapolation.

The values of $\underline{B}$ so derived were subjected to analysis of variance with Groups as a between subjects factor, and Stimulus Pairs as a within-subjects factor. This analysis suggested that $\underline{B}$ did not vary systematically as a function of groups, $\underline{F}(2,27) = 0.67$, $\underline{p} > .05$.

DISCUSSION

The results of the present study support and extend some of the findings of previous analyses of social modeling influences on pain. Data from the ascending shock series indicated a substantial impact of exposure to a tolerant model upon verbal reports of pain threshold and pain tolerance. This finding exactly replicates the solidly-established tolerant modeling effect and is of relatively minor theoretical and empirical interest except insofar as it establishes that the effect is observable even when subjects have had prior exposure to the stimulation. This latter finding confirms those of Craig and Ward (Note 2) who were able to demonstrate a within-subject enhancement of pain tolerance when subjects were exposed in an initial session to an inactive co-participant who became active and tolerant in a second session. These authors' findings were more substantial, however, in that they demonstrated that an initial enhancement of pain tolerance resulting from exposure to a tolerant model was subsequently maintained when the active modeling influence was removed. Taken together, these findings are theoretically interesting in that they demonstrate the plasticity of pain behaviours in response to variations in social conditions. Further, they confirm that the manipulated variable was powerful enough to provoke alterations in pain responses in spite of prior exposure to the stimulation. This finding represents solid evidence that pain behaviours are sensitively responsive to and substantially controlled by social variables.

The data from subjects in the intolerant group was sufficiently unusual to warrant separate consideration. The results from analyses employing all subjects who completed the ascending series of session 2 indicated that exposure to an intolerant model had no effect upon pain threshold, but pro-

duced a significant reduction in current levels associated with a pain tolerance rating. However, if only the data from subjects who completed the SDT series were included in the analysis, neither pain threshold nor pain tolerance levels differed from those observed during baseline conditions or from those observed in the control group. This inconsistency between the two analyses suggests that the SDT series was entirely too stressful for those subjects exhibiting maximal influence as a function of exposure to the intolerant model. It seems likely that the outcome of the larger analysis represents a more accurate characterization of the effects of intolerant modeling. Certainly, the differential subject attrition rate in group I suggests that the overall effect of exposure to an intolerant model made subjects especially intolerant of the stimulation. With regard to those subjects in group I who completed the SDT series, other data suggest that these subjects, too, exhibited greater intolerance for the shocks than did subjects in the other groups. The findings from the analysis of frequencies of category choice (Figure 1:3) show that subjects in group I more frequently selected category ratings from the upper end of the scale when describing their reactions to the higher intensity shocks. These data, then, support the conclusion that exposure to an intolerant model did, in fact, make subjects more intolerant of the stimulation.

The fact that subjects in group I did not differ from control subjects in pain threshold levels was interesting, particularly since earlier studies had found reductions in pain threshold as a consequence of exposure to an intolerant model (Craig & Best, 1977; Craig, Best, & Ward; Craig & Coren, 1975; Craig & Niedermayer, 1974; Craig & Weiss, 1971). In order to determine whether the failure to observe a difference in pain threshold may have been a consequence of having to recruit new subjects in order to re-

place those who dropped out during the SDT series, the overall ANOVA on pain threshold values was re-conducted, employing only the data from the first 10 subjects assigned to group I. This analysis revealed that pain threshold values still did not differ between groups I and C. It must be pointed out that the finding of a significant difference in this re-analysis would have provided support for the proposed alternative explanation; however, the finding of no differences cannot be taken as supportive or non-supportive.

Comparison of influence session pain threshold values for the 3 groups in the present study with those reported in the previous studies employing tolerant, intolerant, and control groups revealed that the means for groups T and C fell within the midrange of the values reported in previous studies. However, the mean for group I (5.00 mA) was slightly higher than the highest mean reported for an intolerant group in previous studies (4.20 mA; Craig, Best, & Ward, 1975). Interestingly, in all but one of the previous studies incorporating all 3 groups, differences in current intensities provoking a pain threshold rating have been substantially greater between tolerant and control than between control and intolerant groups. Data to be presented in the third experiment in this series suggest an explanation for this outcome, and further discussion of it will be postponed until the general discussion.

The analysis of current intensities administered during the SDT series confirmed that there were no differences in overall levels of current administered to the 3 groups. Thus, current intensities were not confounded with groups and therefore, criticisms applied to previous SDT studies of modeling influences do not apply to the present study. Results of the analysis of frequencies of category choice indicated that the 3 groups were,

in fact, differentiable in terms of their response distributions, particularly at the moderate and high shock intensities. Thus, the effects of the modeling influence were maintained during the SDT series. As can be seen in Figure 1:3, the effects of modeling were consistent with those observed during the ascending series, with subjects in group T less frequently employing response categories indicative of greater pain, and subjects in group I more frequently employing categories indicative of greater pain.

Analysis of data from the forced-choice SDT task indicated that there were no between-group differences in the discriminability of pairs of currents that differed by a standard 0.25 mA at low, medium, and high stimulus intensity levels. The findings based on this forced-choice task measure of discrimination paralleled those based on standard parametric procedures (d') and those based on nonparametric procedures (P(A)) at the same stimulus intensities. Clark and Dillon (1973) and Clark and Mehl (1973) suggested that forced-choice tasks provide more accurate and reliable data in pain studies than do rating-scale tasks. Since the outcome of the forced-choice analysis was similar to the outcome of analyses of data derived from the rating-scale task at the same stimulus intensities, it would seem reasonable to conclude that interpretation of the rating-scale data does not present particular difficulties as a result of inferior measurement.

Of further interest in the analysis of data from the forced-choice task was the fact that the discriminability of pairs of stimuli at low, medium, and high intensities did not differ. This outcome is inconsistent with what would be predicted on the basis of Weber's law. As mentioned previously, SDT studies of modeling influences on pain have been criticized on the grounds that current intensities administered were confounded with groups, and the

outcome of the studies could be fully accounted for on the basis of Weber's law. Since the discriminability of stimulus pairs did not vary inversely with overall stimulus intensity in the present study, this criticism of previous SDT analyses of modeling influences on pain would seem to be inappropriate.

The outcomes of SDT analyses of the rating-scale task lent further support to the hypothesis that the modeling influence procedures are capable of producing alterations in sensory sensitivity to noxious stimulation. The analysis of discriminability indices based on the parametric measure, d', indicated that subjects in group I exhibited enhanced discrimination when judging the highest of the stimuli selected from just below their pretest pain threshold and the lowest of the stimuli selected from clearly painful levels. Since it was unclear whether data upon which calculation of d' was based met the strong Gaussian assumptions underlying parametric procedures, comparable analyses were conducted on the nonparametric measure estimating the area under the ROC curve. This analysis resulted in a similar outcome; subjects in group I exhibited enhanced discrimination of the same shock pairs as in the parametric procedure relative to subjects in group C. The fact that this finding was based on a one-tailed test of significance may present some difficulties in fully accepting it; however, the hypothesis being tested was directional, and the test employed (Dunnett's) was more conservative than the one-tailed orthogonal t-tests employed by Craig and Ward (Note 2).

This finding closely replicates that of Craig and Coren (1975) who observed an enhancement of discriminability at current levels slightly below pain threshold among subjects exposed to an intolerant model. The results of the present study extend the finding of Craig and Coren in that enhanced discriminability occurred at clearly noxious stimulus intensities.

In none of the previous SDT studies of modeling influences on pain has there been a demonstrable effect upon response-bias. In the present study, no between-group differences were obtained with the parametric measure, L_x, in terms of the mean of bias extimates calculated at all criteria and stimulus pairs, or at the criterion for very faint pain. Similarly, when the nonparametric measure B was employed, no between group differences were observed. However, alternative evidence is consistent with a proposed bias against reporting pain in group T. Observation of Figure 1:3 reveals that at stimulus levels of moderate and high intensity, subjects in group T tended to distribute their responses more frequently toward the end of the rating scale indicating minimal discomfort than did subjects in the other groups.

The lack of findings with regard to discriminability in group T is problematic in the light of previous reports that tolerant modeling is associated with reduced discriminability (Craig & Prkachin, 1978; Craig & Ward, Note 2). A consideration of methodological differences among the studies suggests some possible resolutions of this paradox. In the present study, stimulus intensities presented during the SDT series were selected from 3 levels based on subjects' performance under uninfluenced conditions. In the study by Craig and Prkachin, 5 standard stimulus intensities, differing by 1.0 mA were presented to all subjects. In the study of Craig and Ward, 10 stimulus intensities were presented in the SDT series. The intensity of the maximum stimulus presented to each subject was 80% of the mean terminal

current accepted during the preceding ascending series, and the other 9 stimuli differed in equal proportions (8% of this maximum current). For the vast majority of subjects, this would have meant that adjacent stimulus pairs differed by 1.0 mA or less. In the present study, it was not unusual for differences between stimuli to be greater than 2.0 mA. If, for some reason, reductions in discriminability resulting from exposure to a tolerant model only occur between stimuli differing by less than the modal intensity difference employed in the present study, opportunity to observe a difference would have been missed. Also, since the stimuli in the present study were selected from relatively discrete points, the sampling of responses at various points of the pain intensity continuum may have been less adequate than in previous studies. If discriminability differences as a function of tolerant modeling only occur at specific points along this continuum, those points may have been missed in the present study. Certainly, there is precedent for observing such a phenomenon in SDT pain research. In the present study, differences only emerged in the intolerant group between one specific pair of stimuli. Chapman, Murphy, and Butler (1973), in a study of analgesic effects of nitrous oxide were only able to demonstrate discriminability reductions when $\underline{d}'$ was calculated between low, medium, and high stimulus intensities and a blank stimulus. Chapman, Gehrig, and Wilson (1975), in a study comparing analgesic effects of acupuncture and nitrous oxide, argued from their findings that, unlike acupuncture, nitrous oxide only reduced $\underline{d}'$ at very low stimulus intensities. Lloyd and Wagner (1976) reported that acupuncture reduced $\underline{d}'$ only between a blank and very weak stimulus.

An alternative explanation for the inconsistency between the present study and earlier studies that reported positive findings with regard to the

influence of tolerant modeling on discriminability derives from the fact that considerably more presentations of each stimulus intensity were employed in the present study. SDT tasks typically employ very large numbers of trials. It has been argued that in SDT pain studies where few stimulus presentations are employed, subjects respond unreliably (Rollman, 1977; but see Chapman, 1977). The implication is that when subjects' ratings do not attain an adequate degree of reliability, spurious findings may result. Also, any condition that reduces reliability may compound the problem. Since rating reliability is proportional to the number of stimulus presentations employed, the present study was less subject to this problem than were the previous studies. However, simple rating unreliability cannot account for previous tolerant modeling effects, unless it is posited that exposure to a tolerant model produced differentially greater unreliability. If the presence of a tolerant model produced particularly unstable responding, a spurious difference could have resulted. If the studies reporting positive findings had employed groups exposed to an intolerant model, it would be possible to evaluate this alternative, since an intolerant model would likely have produced equally unstable ratings, but discriminability should have increased.

A final point is in order concerning the paradigm employed in the present study. Recent reviews of applications of SDT to pain research have pointed out that in the absence of inclusion of a blank stimulus, nothing can be concluded about the absolute sensitivity of subjects to the stimuli presented in pain studies (Lloyd & Appel, 1976; Rollman, 1977). There is, however, some confusion regarding what is meant by "blank stimulus". As Hall (1977) has stated, the term may refer to "zero intensity" on the continuum of noxious experience, or it may refer to "zero stimulus energy". The latter case raises the interesting possibility that some stimuli may

be capable of provoking events on the continuum of noxious experience that take on negative values. If by "blank stimulus" is meant "zero stimulus energy", then the measures in the present study reflect relative sensitivity since no such stimulus was presented. It is unclear that inclusion of a zero energy stimulus would have provided more information, since, in a recent SDT study in this laboratory that did employ a blank, subjects exhibited no confusion in their ratings. At any rate, even if the measures reported in the present study do not reflect absolute sensitivity, the conclusion that exposure to an intolerant model fundamentally alters sensory-discriminative aspects of subjects' response to noxious levels of stimulation need not be altered.

Experiment 2. A sensory-decision theory analysis of social modeling influences on nonvocal pain expressions.

The dependent variable in most studies of pain in humans is most often the subject's verbal report (Agnew & Merskey, 1976; Crockett, Prkachin, & Craig, 1977; Hardy, Wolff, & Goodell, 1952; Hilgard, 1969). For many purposes, such measures are sensitive, reliable, and discriminating (Craig & Niedermayer, 1974; Hilgard, 1969). Data from these methods are ordinarily used to make inferences with regard to the internal experience of the subject. Magnitude estimation procedures, for example, are taken to provide information regarding the rate of growth of noxious sensationa; SDT procedures provide evidence on sensory sensitivity and test-taking set.

Such data are of obvious importance in assessing the effects of social influence procedures. However, the information that they and other measures provide is not interchangeable, and different indices can exhibit uncorrelated variations (Craig & Prkachin, 1978). Given the multidimensional nature of pain, a variety of dependent measures is required in order to adequately map the effects of social influence procedures.

Laboratory studies of social influences on pain are designed to clarify processes thought to be operative in the natural environment. In the natural setting, overt expressive behaviour is of

critical importance since it provides a basis for differential responses on the part of members of the social milieu. While previous studies investigating social modeling influences on pain have indicated that such procedures can have a substantial impact on psychophysical measures thought to reflect subjective experience, evidence that the procedures alter overt, nonvocal expressive behaviour would provide a powerful demonstration of the importance and external validity of the findings from such research.

Observers employ nonvocal expressions as supplementary, or sometimes fundamental sources of information regarding the internal state, or other conditions controlling the observed individual's behaviour (Fordyce, 1978b; Kraut, 1978; Sternbach, 1974). Grimaces, other signs of distress, guarded posture and the like are critical cues for the diagnostician evaluating the severity of a pain problem, and the nonprofessional responding to evidence of pain. A substantial literature has emerged suggesting that a variety of "affective states" may be accurately inferred from nonvocal expressive displays (Ekman & Friesen, 1965, 1974a, 1974b; Waxer, 1974, 1977). Some authors have forwarded the position that nonvocal expressions are less subject to motivated dissimulation than verbal reports, and may therefore be more accurate indices of private states (cf. Ekman & Friesen's, 1969, concept of "nonverbal leakage").

Despite their importance, few studies have examined the influence of social variables on nonvocal pain expressions. Lanzetta, Kleck, and their

colleagues have investigated parameters regulating nonvocal expressive responses to noxious stimulation and the relationship between expressive responses and indices of self-reported distress. Lanzetta, Cartwright-Smith, and Kleck (1976) reported parallel changes in autonomic and self-report indices of stress among subjects instructed to intensify or attenuate facial responses to painful stimuli. Kleck, Vaughan, Cartwright-Smith, Vaughan, Colby, and Lanzetta (1976) examined relationships between expressive behaviour, electrodermal activity and self-reported pain among subjects being observed by someone else, or undergoing the experiment alone. Subjects being observed exhibited diminished evidence of distress as indicated by independent ratings of facial expressiveness, diminished electrodermal responsiveness, and less self-reported pain. It was argued that these findings supported the thesis that modulations in expressive behaviour instigate parallel changes in subjective and autonomic components of response to noxious stimuli.

In studies of modeling influences on pain, the actual behaviour exemplified by models has been tolerant or intolerant characterization of noxious stimuli. The question of whether the modeling influence generalizes to overt expressive behaviour, important in affective interpersonal situations, has not been addressed.

The present study was designed to investigate two issues. The first was whether observers can discriminate expressive behaviour resulting from different intensities of noxious stimulation. Assuming that observers could reliably discriminate the expressive behaviour associated with different current intensities, the second question addressed was whether observers' ratings of the expressive behaviour of subjects exposed to tolerant or intolerant modeling or control conditions would exhibit systematic variations.

Sensory-decision theory was employed as a technique for evaluating these questions. If an individual is given the task of observing the behaviour of another and specifying whether, or to what extent a particular event has occurred, then the data obtained from the observer can be analysed with SDT methods. The outcome of such an analysis will provide a measure of the observer's ability to differentiate the classes of events, and his or her bias in favour of or against reporting an event. In the present study, raters observed the behaviour of subjects exposed to the 3 influence conditions of Experiment 1, and made judgements as to the level of current administered on each of a series of trials. Previous research as indicated that exposure to tolerant or intolerant models, respectively, decreases or increases pain reports and produces alterations in avoidance behaviour consistent with altered reports. Evidence from psychophysiological studies indicates as well that the tolerant modeling manipulation produces diminished reactivity to noxious stimulation, while the intolerant condition may be associated with increased reactivity. On the basis of this evidence, in the current study it was expected that the tolerant modeling condition would influence subjects to be less reactive to the stimuli. It was hypothesized, therefore, that observers rating subjects in the tolerant condition would exhibit poorer discrimination while observers rating subjects in the intolerant condition would exhibit enhanced discrimination.

METHOD

Subjects. Fifteen paid female volunteers were recruited from the undergraduate population of the University of British Columbia to take part in four separate sessions as observing judges. Subjects were randomly assigned to three groups of five persons each.

Apparatus and Materials. Videotapes taken of participants undergoing the signal detection phase of the second (influenced) session of the first study were shown to subjects on a 23 inch television set via a Sony AV3400 videotape recorder playback unit. Above the television screen was mounted a sheet of cardboard displaying the rating categories that subjects were to employ. Subjects coded their responses directly onto Fortran coding forms.

Nine of the 10 videotapes from each of the 3 groups of subjects in the first study were selected for viewing. The videotapes of one subject from each of the Tolerant and Intolerant groups were randomly excluded from presentation in this part of the study. Excluded as well was the tape of the one subject in the control group who did not complete the entire signal detection series. Each set of nine tapes so formed was randomly divided into three groups of three subjects.

Procedure. When all five observing subjects in a group arrived at the laboratory for the first session, they were greeted by a female experimenter who read a standard set of instructions. The experiment was described as being concerned with the way people "...differentiate the behaviour....of other people who are experimenting various levels of pain." The content of the videotapes was then explained as follows:

> The people that you will be watching took part in an experiment on the perception of pain. They were seated in the laboratory and had an electrode attached to their arm. Then they were exposed to

> a series of electric shocks, starting at undetectable levels, that gradually increased in intensity until they got painful. The shocks increased some more until the subjects told us they were painful enough that they would tolerate no more. After doing this a few times, three different pairs of currents were determined. The first pair was at an intensity that the people reported as just barely detectable. The second pair was at a stronger intensity and the third pair was at an intensity beyond what they said was painful. So there were three levels of pairs of shocks: low, medium, and high. These three levels were then presented ... to the subjects many times ...in a random order, and each occurred an equal number of times.

No mention was made of the influence conditions that observed subjects underwent.

After this description of the task, observers were instructed in their task. Following each trial observers were to indicate whether they thought that the shock level experienced on the trial was of high, moderate, or low intensity. The instructions then continued:

> ...before we start with the experiment itself, we usually find it best to provide you with a little bit of practice beforehand. So what I'll do is show you a couple of practice tapes. As we go through, pay close attention to the behaviour of the person you are watching. Look for any signs in their behaviour that will give you a clue as to the level of shock they're receiving and how much pain they're feeling.

Before the session began, observers were also instructed to distribute their responses well, and make use of all the categories.

Following instructions, the practice trials began. During these trials, subjects observed two of the three tapes which had been randomly excluded from presentation in the major part of the study. Following each trial in the practice series, the experimenter provided feedback by telling the raters which of the three current levels the subject had received.

When the practice trials had been completed, the experiment proper began. Each sample of five observers rated all tapes in one of the three "squads" of three randomly-selected subjects from each of the influence conditions of the first study. In order to assess repeated measures reliability, all observers in each sample rated the same tapes from their respective "squad" twice in different sessions. The tape of each observed subject was comprised of 18 examples each of behaviour elicited by low, medium, and high current intensities. The mean current intensities for each group of observed subjects are presented in Table 2:1.

Following the practice trials, observers were not continuously informed what shock level the subject received. However, in order to guard against the possibility of performance deterioration by the observers, the experimenter provided feedback on a randomly selected 33% of trials. When observers had completely finished their ratings of each tape, they completed a questionnaire consisting of two 7-point Likert scales asking them to rate the amount of distress exhibited by the subject and the ease or difficulty of rating the subject.

Four testing sessions of approximately two hours in length and spaced at one week intervals were required to complete data collection.

Table 2:1

Means of Low, Medium, and High Current Intensities

Administered to Observed Subjects.

Group	Low	Current Intensity Medium	High
Tolerant	0.88	3.73	6.95
Control	1.13	4.00	7.28
Intolerant	1.19	3.97	6.33

Note: Means are in milliamperes and represent the mean of two intensities at each of the low, medium, and high levels.

RESULTS

For the purposes of SDT analyses, conditional probabilities of occurrence of each response given the occurrence of an example of subject behaviour following presentation of each of the three pairs of shock intensities were calculated. These probabilities were then cumulated from the low to the high response category for each stimulus intensity level in the manner outlined by Clark (1974). Following the generation of cumulative probability tables estimates of $\underline{d}'$ and $\underline{L}_x$ were calculated at the "medium" and the "low" response category for the high vs. medium and medium vs. low discriminations. The data so derived were investigated by analysis of variance. Two potential effects were of principal interest in these analyses: (1) whether the SDT parameters varied systematically as a function of the discrimination that observers were required to perform (i.e., did $\underline{d}'$ and/or $\underline{L}_x$ differ between the medium vs. low (ML) and the high vs. medium (HM) discrimination), and (2) whether the parameters varied systematically as a function of the conditions that observed subjects had been exposed to in Experiment 1. It was expected that the HM discrimination would be associated with greater $\underline{d}'$ values than the ML discrimination. With respect to social influence effects, it was expected that observers rating subjects exposed to tolerant models would exhibit reductions in ability to discriminate behaviours resulting from the three different stimulus intensities (a reduction in $\underline{d}'$) relative to the same observers rating control subjects. On the other hand, it was expected that observers rating subjects exposed to an intolerant model would exhibit enhanced discrimination.

For the ANOVAs values of $\underline{d}'$ and $\underline{L}_x$ at each criterion along the rating scale were averaged. These average $\underline{d}'$ and $\underline{L}_x$ values were then averaged

across the three subjects per influence condition that were presented to each observer sample. In order to extract the variance associated with each observer sample-videotape squad pairing, videotape squads were included as a between-groups factor in the ANOVA. The overall design, then, was a 3 (Squads) X 2 (Replications) X 3 (Modeling Conditions) X 2 (Discriminations) ANOVA, with repeated measurements on the last three factors.

Results of the analysis of values of L_x were largely negative. The only effect that approached significance was that for Replications, $F(1,12) = 4.07$, $p = .067$. This reflected observers' tendency to adopt more conservative criteria for reporting the occurrence of higher shock intensities the second time that they viewed each video-tape (M Replication 1 = 0.97; Replication 2 = 1.18).

A number of significant findings emerged from the analysis of d' values. The most important were a significant Discriminations effect, $F(1,12) = 49.60$, $p < .01$, and a significant Modeling Conditions effect, $F(1,12) = 22.59$, $p < .01$. Examination of means revealed that d' values for the HM discrimination were greater than those for the ML discrimination (M d' = 0.65 and 0.21, respectively). Thus, the ability to discriminate shock-elicited expressive responses was closely related to the magnitude of current the observed subject was exposed to.

Mean d' values for the significant Modeling groups main effect were 0.31 for group T, 0.42 for group I, and 0.57 for group C. The differences between all three means exceeded the critical value for Dunn's multiple comparison procedure (t' D .05/2;3,24 = 0.10). Thus observers exhibited reliably lower d' values when observing the behaviour of subjects exposed to an intolerant model relative to when they were observing the behaviour of controls, and they exhibited even lower d' values when observing the behaviour of subjects ex-

posed to a tolerant model relative to when they observed either intolerant or control subjects.

Other significant effects emerged from the analysis; however, they were less readily interpretable since they involved the observer samples variable which was included in the analysis simply to extract the variance resulting from particular observer sample-videotapes squad pairings. The overall Squads effect was significant, $F(1,12) = 7.12$, $p < .01$, indicating that the three observer sample-videotape squad pairings were associated with different overall d' values (means: Sample 1 = 0.50; Sample 2 = 0.57; Sample 3 = 0.23). There was a significant Squads x Replications interaction, $F(2,12) = 5.85$, $p < .05$, reflecting differential patterns of response across both replications for all three samples. The means are presented in Table 2:2 where it can be seen that observers judging subjects in Squad 1 exhibited improved discrimination from Replication 1 to Replication 2, Squad 2 was associated with reduced discrimination from Replication 1 to Replication 2, and Squad 3 exhibited minimal change.

A significant effect was also attributable to the Squads X Discriminations interaction, $F(2,12) = 10.79$, $p < .01$. The means for this effect are presented in Table 2:3 where it can be seen that the magnitude of reduction in d' between the HM and the ML discriminations varied across the three Squads. Squad 1 was associated with the greatest HM to ML decrease in d', Squad 2 an intermediate decrease, and Squad 3 the least decrease. In no case, however, did the overall direction of change in d' differ between squads.

Two further significant interaction effects occurred, both involving the modeling variable: Squads X Modeling Conditions, $F(2,24) = 10.39$, $p < .01$; and Squads X Modeling Conditions X Discriminations, $F(2,24) = 4.52$, $p <$

Table 2:2

Mean d' Values for the Squads x

Replications Interaction

Replication	Squad 1	Squad 2	Squad 3
1	0.40	0.76	0.20
2	0.61	0.37	0.25

.01. Means for the 3-factor interaction are presented in Table 2:4 where it can be seen that while there was a general reduction in d' from the HM to the ML discrimination, observers judging subjects in Squad 3 exhibited inordinately low mean d' values at the HM discrimination. The interaction is not disordinal with respect to the effects of Modeling Conditions. Therefore, the data do not suggest that the overall conclusion that observers rating subjects exposed to a tolerant model exhibited reduced ability to discriminate needs to be qualified significantly.

Global ratings of distress and difficulty.

Observers' ratings on the post experimental questionnaire evaluating the overall level of distress exhibited by observed subjects were entered into the same ANOVA design . The Modeling Conditions term approached conventional levels of statistical reliability, $F(2,24) = 3.33$, $p = .05$. However, multiple comparisons with Dunn's procedure failed to demonstrate that any pair of modeling conditions differed reliably ($t'D\ .05/2,\ 3,\ 24 = 0.68$; Mean distress ratings: Group T = 2.96, Group I = 2.79, Group C = 3.44).

The same model of analysis was employed in evaluating observers' ratings of how difficult each observed subject was to judge. A reliable Modeling Conditions effect emerged from this analysis, $F(2,24) = 11.75$, $p < .01$. Multiple comparisons by means of Dunn's procedure indicated that this effect was exclusively accounted for by the increased difficulty that observers reported when judging subjects exposed to a tolerant model relative to judgements of intolerant and control subjects. Ratings of the difficulty of judging intolerant and control subjects did not differ ($t'\ D.05/2,3,24 = 0.29$; Means: Group T = 5.28, Group I = 4.89, Group C = 4.74).

Table 2:3

Mean *d'* Values for the Squads x

Discriminations Interaction

Discrimination	Squad 1	Squad 2	Squad 3
HM	0.92	0.72	0.31
ML	0.09	0.42	0.14

Note: HM = High vs. Medium discrimination

ML = Medium vs. Low discrimination

Table 2:4

Mean *d'* Values for the Squads x Modeling Groups

x Discriminations Interaction

Modeling Group	Discrimination	Squad 1	Squad 2	Squad 3
1	HM	0.65	0.78	-0.06
	ML	-0.19	0.44	0.23
2	HM	0.78	0.63	0.51
	ML	0.20	0.42	-0.01
3	HM	1.33	0.75	0.48
	ML	0.25	0.39	0.20

A significant Squads x Modeling Conditions interaction was also obtained, $F(2,24) = 17.70$, $p < .01$. Inspection of the means for this interaction (Table 2:5) indicated that when observers rated subjects from Squads 1 and 3 the general trend toward elevated difficulty ratings associated with subjects in group T relative to those associated with subjects in groups I and C held. Ratings of subjects from Squad 2 did not appear to differ across the 3 modeling conditions.

Table 2:5

Mean Difficulty Ratings Associated with each Squad when Observers Made Judgements of Subjects from the Three Social Influence Conditions of Study 1

Squad	Tolerant	Modeling Condition Intolerant	Control
1	5.70	4.73	4.73
2	4.97	5.59	5.67
3	5.17	4.33	3.83

Note: Minimum rating = 1 (very easy); Maximum rating = 7 (very difficult).

Discussion

A number of interesting findings emerged from this study. The results may be summarized as follows. Observers, in general adopted fairly stable decision criteria when making judgements of the level of current that observed subjects were exposed to. This conclusion is based on the fact that the ANOVA performed on values of L_x did not reveal any statistically reliable variation as a function of the manipulated variables. Observers were capable of discriminating differences in the behaviour elicited by low, medium and high shock levels as evidenced by the fact that d' values were generally greater than zero. The discriminability of observed subjects' behaviour varied systematically as a function of the type of discrimination that observers were required to make. The difference between behaviour controlled by high and medium current levels was more readily discriminated than was the difference between behaviour controlled by medium and low current levels. The discriminability of shock-elicited expressions varied systematically as a function of the modeling condition of the observed subject, with the behaviour of subjects exposed to a tolerant model associated with the lowest values of d', and the behaviour of subjects exposed to an inactive co-participant associated with the highest d' values. Variation in this effect occurred across the 3 videotape squads, however, the nature of this variation was not such as to call into question the general association of reduced d' values with subjects in the tolerant modeling condition. Observers' ratings of the amount of difficulty they had in making the discriminations indicated that they found subjects in the tolerant group more difficult to judge than subjects in the other groups. Finally, observers' post observation ratings of the amount of distress exhibited by observed subjects varied with the modeling condition of the observed subject.

While there have been several attempts to apply SDT methods to social processes (Grossberg & Grant, 1976), only one other study has extended SDT procedures to the analysis of overt social behaviour in humans (Thompson, 1978). Therefore, both methodological and substantive issues require discussion. The fact that the HM discrimination was associated with greater values of d' than the ML discrimination solidly supports the utility of SDT procedures in investigations of pain-elicited expressive behaviour. Clearly, substantial quantitative and/or qualitative differences in expressive behaviour are produced by electric shocks varying across global intensity levels. This occurred even in a relatively impoverished laboratory environment where direct visual contact between subject, co-participant, and experimenter was eliminated. The fact that the videotape camera was present and in subjects' clear view in the session during which their behaviour was taped was of some concern, since previous investigators have intimated that subjects will actively monitor and minimize their expressive behaviour when they know that it is being recorded (Lanzetta et al., 1976; Kleck et al., 1976). Since positive nonzero d' values were the rule in this study, and since values of d' varied systematically with the type of discrimination that observers were required to make, it appears that such a phenomenon either did not occur or was of minimal importance.

Other, unsystematic data support this contention. During the debriefing that followed Experiment 1, most subjects exhibited considerable surprise when informed that part of the purpose of the study was to analyse the recordings of their expressive behaviour. Almost all subjects reported having forgotten that they were being recorded. Furthermore, since these subjects were tested and had their behaviour recorded over an extended period of time, it seems unlikely that they would have maintained such a "censorship" of their expressive behaviour.

The meaning of the measure, d' as applied to the data from this study requires further elaboration. d' provides an index of the discriminability of 2 or more classes of events. In the present case, the events of interest were the overt expressive behaviours of subjects, elicited by each of the 3 stimulus levels that they were exposed to. The current intensities presented to observed subjects were selected, prior to their undergoing pain-modulating manipulations, from 3 global levels: (1) the nonaversive sensation threshold, (2) slightly below pain threshold, (3) the clearly painful midpoint between pain threshold and pain tolerance. Only the latter stimulus level would be expected to reliably provoke expressive responses clearly indicative of "pain". Since d' values increased markedly from the ML to the HM discrimination, it is reasonable to infer that this improvement in observers' performance was contingent upon the occurrence of salient behaviours on the part of the observed subject that met a consensual definition of pain. Thus, in the present context, it appears that observers' discriminations were controlled largely by the occurrence of behaviours indicative of pain, and in this sense it can be argued that the greater d' for the HM discrimination resulted from expressive behaviour indicative of pain.

This interpretation of d' lends further importance to the finding of reliable differences in discriminability as a function of the modeling condition of the observed subject. The presence of any concurrently-verbalizing model, tolerant, or intolerant, was associated with a reliable reduction in the discriminability of an observed subject's behaviour. Furthermore, if the model was tolerant, there was a reliably greater decrement in the discriminability of the observed subject's behaviour. It had been expected that the intolerant modeling condition would be associated with an increment in the discriminability of the behaviour of subjects in this condition.

This outcome presents some interpretive problems. While in Experiment 1 these subjects gave evidence of experiencing greater amounts of pain, they did not manifest nonvocal expressive behaviour that allowed observers to readily discriminate the actual intensity of noxious stimulation they experienced or the amount of distress they reported. One implication of this finding might be that the impact of social modeling influences on pain behaviour was not consistent across measures. However, this conclusion does not seem to fully capture the observed outcomes of the experiment. The hypothesized differential reduction in d' among subjects exposed to a tolerant model did occur. Furthermore, the magnitude of the effect was sufficiently large that d' values were lower than those observed among subjects exposed to an intolerant model. Therefore, alternative accounts might be equally plausible.

Two further considerations might account for the finding. First, subjects in the intolerant group were exposed not only to the formal content of the confederate's ratings, but also to the model's expressive style while making the ratings. While the actual ratings made by the model indicated the experience of greater amounts of pain than the subject was reporting, the manner in which the model made her ratings was, in fact, quite dispassionate. As Epley (1974, p. 273), in a review of the effects on reactions to aversive stimulation of the presence of companions has noted, "A companion that emits calm responses in a threatening situation may elicit similar behaviours from the observing subject." It seems likely that the reduced discriminability of the behaviour of subjects exposed to an intolerant model was controlled by the relatively calm expressive style of the model. Subjects exposed to an inactive co-participant were not exposed to expressive communication from their companion; hence, their own expressive behaviour

was likely relatively uninfluenced. The adequacy of this interpretation could readily be assessed by direct manipulation of formal and expressive aspects of the model's communications.

An alternative explanation for reduced discriminability of the behaviour of subjects exposed to an intolerant model relates to the excessive dropout rate of subjects in this group in Experiment 1. It may have been that those subjects most likely to exhibit enhanced pain displays as a function of exposure to an intolerant model were so distressed by the procedures that they terminated the experiment. Thus, the finding of reduced discriminability in this group may have been an artifact resulting from selection for subjects who would exhibit minimal distress upon exposure to the procedures.

Regardless of whether either of these explanations is correct, the finding that the behaviour of subjects exposed to a tolerant model was less discriminable than the behaviour of subjects in both of the other groups was of substantial interest and was consistent with their verbal report of pain in Experiment 1. In addition to reducing reports of pain and avoidance of stimulation at greater intensities, tolerant modeling seemed to quite clearly reduce the emission of nonvocal behaviours indicative of the presence of pain. This finding is particularly important for social accounts of the origins of variations in styles of response to painful stimulation for at least two reasons. First, it identifies a specific set of social antecedent conditions that control overt displays of pain. Second, the effect of this set of antecedents--removal or reduction of pain displays--can be conceived of as minimizing the occurrence of a set of social discriminative stimuli that may set the occasion for behaviours on the part of others that are implicated in the shaping or maintenance of pain behaviour.

The various interaction terms which attained statistical significance

in the ANOVA of d' values were of little interest, since in no case was it indicated that the overall conclusions with respect to the main effect of modeling conditions needed to be qualified. Similar overall patterns held for the effects of modeling conditions across the 3 observer sample-videotape squad pairings; however, the magnitude of these effects varied somewhat. The interactions seem quite clearly to result from idiosyncratic response styles of the specific subjects whose tapes were assigned to a given squad.

Results of the severity of distress and difficulty of judgement ratings corroborate the findings with regard to discriminability. There was a significant modeling groups effect in the distress rating analysis. Multiple comparisons revealed that no pair of groups differed from each other. This suggests that ratings were relatively homogeneous within some pair of the groups, relative to a third group. Observers' ratings of distress were lower when judging both tolerant and intolerant subjects relative to controls, suggesting that these groups combined accounted for the marginal effect. Since d' was reduced in both groups, this marginal finding mirrors the pattern of differences with respect to discriminability, and further supports the interpretation of d' as a measure of expressed pain. Analyses of observers' difficulty ratings revealed that subjects in the tolerant group were reliably more difficult to judge than were subjects in the other groups. Assuming that observers relied upon the occurrence of a particular set of cues to base their ratings upon, it would seem that these cues tended to occur less frequently among tolerant subjects. This finding may reflect a further absence of pain cues among tolerant subjects in addition to mirroring the marked reductions in the discriminability of their behaviour.

Experimental studies of the effects of pain modulation procedures on humans have relied almost exclusively upon verbal characterizations

of the experience of pain as a dependent variable. This trend in the research reflects Hilgard's (1969) conclusion that such measures are highly discriminating, replicable, and lawful. However, investigators interested in social processes related to pain require something more, in that their concern is with the social behaviours indicative of pain, and the social milieu in which pain and its indicants occur. The present study has demonstrated the utility of a methodology that is based directly upon the overt, socially-relevant pain behaviour of the individual, and is readily adaptable to many experimental settings.

The impact of the variables manipulated in this study was almost exclusively upon discriminability. It is of interest to speculate about the types of variable that might be associated with alterations in observers-decision rules (criteria) in the type of task employed in this study. Evaluations of the amount of pain an individual is experiencing are commonplace in clinical settings. Such evaluations are based not only upon the presence of direct evidence that pain is being experienced, but also upon available background information with regard to the individual, and the prior experience of the diagnostician. Certain types of background information are very likely to influence the diagnostician's criterion for accepting evidence that a significant amount of pain is present. Some examples of the types of background information likely to influence judgements of pain include: the patient's ethnic background, the history and chronicity of the problem, the emotional or psychiatric status of the patient (e.g., is s/he "neurotic" or "stoical"?), "payoffs" associated with evidence of pain such as compensation, "secondary gains", etc. Other variables like the observer's experience with pain expressions are likely to contribute to this process. It is conceivable, for example, that individuals who live in a family where one

member has a chronic pain problem may come to exhibit different criteria for evaluating pain as a function of their increased exposure to evidence of its presence. Indeed, in the present study, the finding that observers tended to employ more conservative criteria for reporting higher magnitudes of shock during their second viewing of each subject suggests that greater experience with expressions of pain alters evaluators' decision rules for reporting its presence in others. Determining the contribution of such variables to decisions regarding the presence or magnitude of pain is a critical step in understanding the complex phenomena of clinical pain and its diagnosis. The methodology employed in the present study seems a particularly appropriate one for examining these issues.

Experiment 3. An investigation of vicarious influences on pain communications employing naturally-occurring groups.

Research on social influence via modeling procedures has had important consequences in three respects. First, such research has uncovered a major source of variation in social behaviour. Second, modeling research has led directly to the development of procedures effective in altering problematic behaviours, particularly those characterized by avoidance. Third, findings from modeling research have been employed within the context of theoretical accounts of the origins of various forms of social/emotional behaviour. As one example of the latter, the acquisition of fearful avoidance in the natural environment has been attributed in part to the modeling of fearful behaviour exhibited by others in specific situational contexts (Rachman, 1972; Bandura, 1969,1976). More germane to the present discussion, Fordyce (1976a), Craig (Note 1, 1978b), and others have argued that differences in pain-related behaviour can, in part, reflect variations in socialization experiences. In particular, relative tolerance or intolerance for noxious stimulation may largely be the product of exposure to others displaying relative tolerance or intolerance of the same stimulation. Similarly, stylistic differences in the particular forms of pain behaviour emitted in such contexts may be mediated by the modeling process.

Previous laboratory investigations have been concerned with demonstrating the occurrence of a modeling effect, evaluating the impact of modeling on a variety of dimensions of the experience of pain, and examining other influences that may modulate the effects of modeling. These investigations and the preceding studies in the present series have demonstrated that the effects are robust and observable across a variety of parameters of response to painful stimulation. It has been suggested that these findings are descriptive of naturally occurring variations in pain behaviour. However, relatively less attention has been paid to examining this "etiological" implication.

There is a number of empirical lacunae in accounts of the origins of differences in style of response to painful events that are based on modeling research. Laboratory research allows stringent control over variables that have potential or known effects on pain. However, the controls can eliminate sources of influence that may be important in the natural environment.

Social interaction provides for reciprocal influence in that individuals responding in the same situational context may come to alter the behaviour of one another (Skinner, 1953; Bell, 1968; Kanfer and Grimm, 1976; Bandura, 1978). Traditionally, however, modeling research has been directed toward examinations of unidirectional influence. The possibility exists that this experimental constraint may limit the range of phenomena observed. That is, an experimental paradigm in which mutual influence is provided for may reveal novel or unusual phenomena.

A second theoretical limitation of modeling research with the paradigm used previously is that it fails to adequately predict the relative power of varying styles of pain behaviour. That is, given a situation in which two individuals exhibiting differing levels of naturally-occurring pain tolerance have the potential to influence one another, there is no empirical basis for predicting whose behaviour will change more. In the present study, the previously employed modeling paradigm was modified by selecting groups of subjects who differed in styles of pain behaviour under uninfluenced conditions. Subjects who exhibited relative tolerance or relative intolerance for pain were chosen. These subjects then participated in a second session matched in pairs in order to examine whether influence would be reciprocal. During the influence session, pairs of subjects were either similar or different in terms of their previously ascertained pain behaviour. It was expected that similar pairs would exhibit more pronounced tendencies in the direction of their original style of response (i.e., that intolerant subjects would become more intolerant, and that tolerant subjects would become more tolerant). In contrast, it was hypothesized that in dissimilar pairs, subjects from each group would become more like subjects from the other group (i.e., intolerant subjects would become more tolerant, and tolerant subjects would become more intolerant). This paradigm also allowed an examination of the relative influencing power of the two forms of behaviour.

METHOD

Subjects. One hundred twenty-seven females were recruited by telephone from undergraduate Psychology classes at the University of British Columbia and were paid for their participation in a two-part experiment "on the topic of perception". Mean age of the subjects was 19.1 (SD = 1.7).

Apparatus. The equipment employed was similar to that used in the first study except that it was modified to provide the capacity to administer current to two subjects simultaneously.

Procedure.

Session 1. Upon her arrival at the laboratory, the subject was seated in a room adjacent to the experimental chamber and the experimenter read to her a standard set of instructions describing the nature of the experiment and provided assurance regarding the safety of the techniques. After assuring the subject that her participation was entirely voluntary, and that the study could be terminated at any time, opportunity to withdraw was provided. Three subjects indicated their unwillingness to continue at this point. A further 4 subjects were excluded because they had not had a physical examination within the past year. Subjects willing to take part gave written consent at this point, and were then escorted to the experimental chamber where the following instructions were read:

> I am going to present you with a series of currents that will start at undetectable levels and will gradually increase. Your task will be to indicate how uncomfortable each one feels by assigning it a number ranging from zero up to 10 or above. Initially, the currents will be so low that you will probably feel nothing. If this is the case, the rating "0" for "undetectable" is appropriate.

> Thereafter, they will gradually increase in intensity and discomfort. I want you to assign each one a number that corresponds to the amount of discomfort that you feel. For example, if you give one current a rating of "2" and then a later one feels twice as uncomfortable, assign the later one a rating of "4" .... The current will eventually reach a level that you would describe as giving you a sensation of pain. We would like you to give that current a rating of 10 or above. When you judge a current to be painful, and give a rating of 10 or above, no more will be given you.

Subjects were then provided with the opportunity to ask questions. When it was clear that the subject understood the nature of her task, the electrode was attached to her left forearm and positioned as necessary to reduce the resistance in the skin-electrode circuit to 5,000 ohms in order to provide uniformity of stimulus strength. Following this, the experimenter retreated behind the partition and commenced the experiment.

Two ascending shock series were administered, starting at 0.0 mA and increasing in 0.5 mA increments until the subject gave a rating of 10 or greater. At the end of the second series, the experimenter removed the electrode and escorted the subject to the adjoining room. She was then thanked for her participation and informed that she might be contacted for a second session. The second session was described as being basically similar "except that we'll be taking some physiological recordings as well". Prior to leaving, the subject was asked not to talk about the experiment to her classmates.

Between the first and the second session of the experiment, average pain threshold scores for the first session were determined and subjects ranked on this measure. Subjects exhibiting a range of pain threshold scores of greater than 3.0 mA between the first and second series were eliminated from the study. Three subjects were eliminated for this reason. Thereafter, the entire group was divided into high and low threshold groups by taking

the top 42 and the bottom 40 subjects of the distribution[1].

Session 2. In the second session, subjects were either run in pairs consisting of combinations of subjects exhibiting high or low pretest thresholds, or participated individually. Three types of dyad were formed: high-high (HH), consisting of 22 subjects (11 pairs) from the high group; high-low (HL), consisting of 10 subjects each from the high and low groups (subjects in this group who had high pretest thresholds were given the designation HL-H, those from the low group were designated HL-L); and low-low (LL), consisting of 20 subjects from the low group. In the event that one subject of a pair did not return for a scheduled appointment, the corresponding member of the pair was automatically assigned to a high (HC) or low (LC) control group, and was run individually. These groups were considered especially important in order to estimate regression-toward-the-mean.

Upon their return for the second session, subjects were casually informed that they were going to be run in pairs in order to finish the experiment more quickly. They were seated in the experimental chamber and had the following instructions read to them:

> Today's session will be very similar to the first session. I will again present you with a series of currents that will start at undetectable levels and will gradually increase. Once again, I would like you to make proportionate ratings of the amount of discomfort that you feel, starting at "zero" for undetectable and increasing thereafter. You will eventually reach a level that you would describe as giving you a sensation of pain. Assign that current a rating of 10 or greater. After you give a rating of 10 or above, we would like you to continue taking current for as long as possible, but the decision is yours to stop at any time. For those currents that occur after you give a rating of 10, continue to make proportionate ratings using any whole numbers

---

1. Owing to an inadvertent scheduling error on the part of the experimenter there were two extra subjects from the high group.

> that you like. When you reach the point where you don't wish to accept any further stimuli, give that current your final rating, pull the switch in front of you to the off position and no more will be given to you.

Each ascending series in the first session was terminated when the subject first reported pain. In the second session subjects were encouraged to accept currents beyond pain threshold up to the point where they were unwilling to continue.

Prior to testing, the experimenter asked one subject to make her rating first. For half of the dyads, the subject having the higher pretest threshold score gave her rating first, while for the other half, the lower member of the pair gave her rating first.

In order to maintain the ruse that in this session the concern was with physiological measures, a "dummy" photoplethysmograph was attached to each subject's right index index finger and its operation was described. Prior to commencing the shock series, the experimenter excused himself to "set a few things up on the polygraph", and left the room for approximately 30 sec. Upon returning, 4 series of electric shocks were administered to the subjects. Each started at 0.0 mA and increased in 0.5 mA steps until both subjects had requested termination of the series.

At the end of the session, the electrodes and plethysmographs were removed, and subjects were escorted to the adjoining room where they completed post-experimental questionnaires. When both subjects had finished the questionnaires, they were fully debriefed and all questions they had about the study were answered.

RESULTS

Pain threshold. Pain threshold data were analysed according to a 6 (Groups) x 6 (Shock Series) ANOVA design with repeated measurements on the Series variable. The first two levels of the Series factor represented performance during the pretest session, while the following 4 levels represented performance under influence conditions for subjects in groups HH, HLH, HLL, and LL or during re-assessment for subjects in groups HC and LC.

Results of the ANOVA indicated a significant overall between groups main effect, $F(5,76) = 27.67$, $p < .01$, and a significant Groups x Series interaction, $F(25,380) = 3.81$, $p < .01$. The main effect for Groups was of little interest since group assignment had been conducted by selecting subjects from extremes of the distribution. Of more interest was the predicted interaction (represented in Figure 3:1) of Groups x Shock Series which was further investigated via a series of planned orthogonal t-tests. Subsequent analyses were performed in order to determine which groups exhibited changes from Session 1 to Session 2, and to compare threshold levels under influence conditions. These latter between-group analyses provided information on which groups exhibited differential changes.

The first set of comparisons examined change from Series 1 and 2 (preassessment session) to Series 3 through 6 (influence session) at each level of the groups variable. The overall t values for each of these comparisons are presented in Table 3:1. The results of these analyses confirm that the decrease in pain threshold value observed in groups HL-H from the preassessment to the influence session and the increases observed in groups HL-L, LL, and LC were statistically reliable.

Figure 3: 1. Mean intensity of current provoking a rating of "10" (pain threshold) overall shock series in Session 1 (pretest) and Session 2 (influence session) for subjects in all groups.

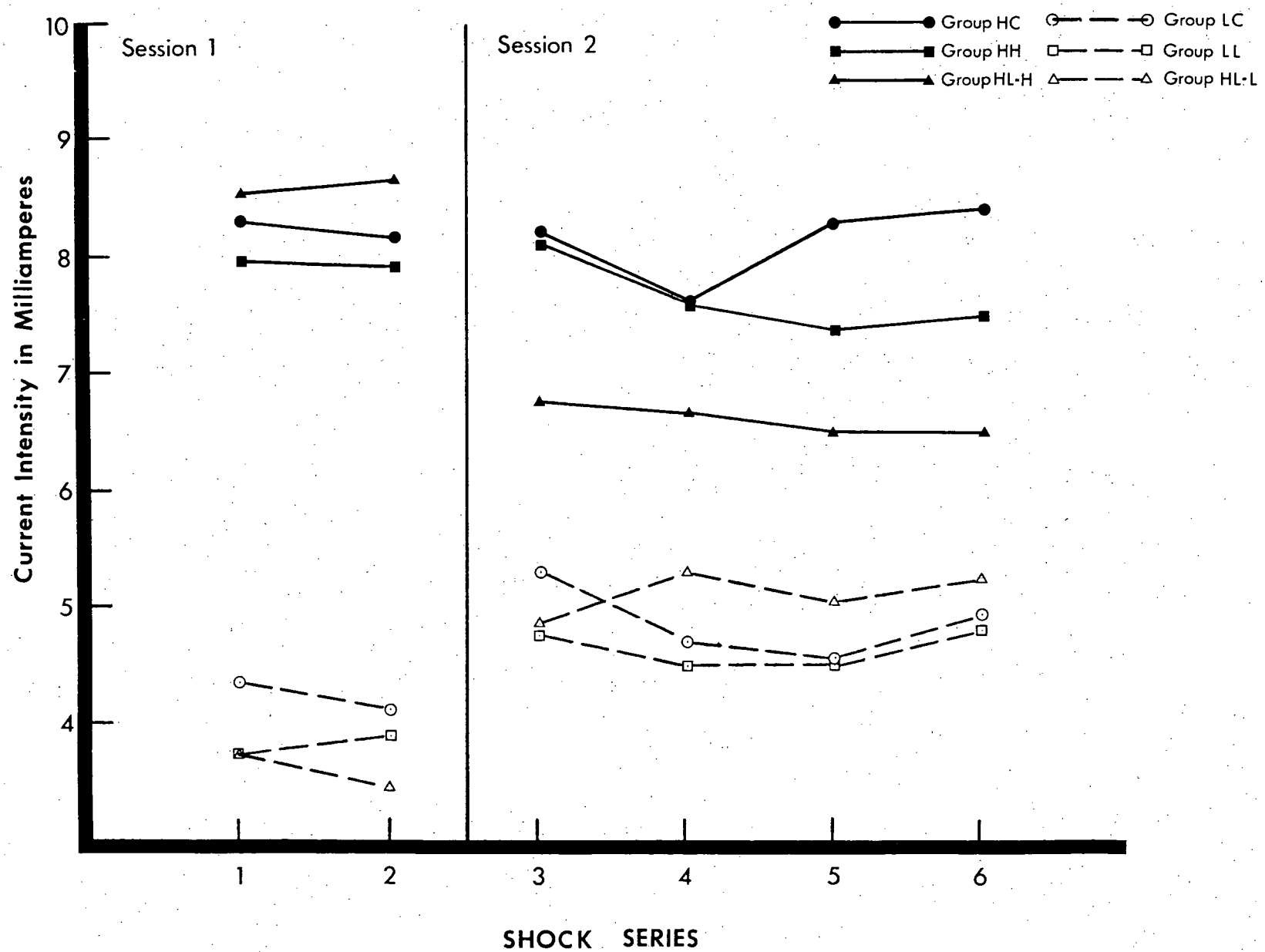

Session 1
Session 2
Group HC
Group HH
Group HL-H
Group LC
Group LL
Group HL-L
Current Intensity in Milliamperes
10
9
8
7
6
5
4
1
2
3
4
5
6
SHOCK SERIES

Table 3:1

Results of Planned Orthogonal Comparisons for Pain Threshold Data

Comparison	Error Estimate	t- Ratio Denominator	t Value		p
S_1,S_2 - S_3,S_5,S_6 at Group 1 (HC)	1.25 (SxS within groups)	1.23	0.33	>	.10
S_1,S_2 - S_3,S_4,S_5,S_6 at Group 2 (HH)	1.25	0.83	1.35	>	.10
S_1,S_2 - S_3,S_4,S_5,S_6 at Group 3 (HL-H)	1.25	1.23	6.52	<	.01
S_1,S_2 - S_3,S_4,S_5,S_6 at Group 4 (HL-L)	1.25	1.23	-4.93	<	.01
S_1,S_2 - S_3,S_4,S_5,S_6 at Group 5 (LL)	1.25	0.87	-3.66	<	.01
S_1,S_2 - S_3,S_4,S_4,S_6 at Group 6 (LC)	1.25	1.23	-2.12	<	.05
HC, HH vs HL-H at Series 3	2.62 (Ss within G SxSs within G, pooled)	1.20	2.35	<	.05
HC, HH vs HL-H at Series 4	2.62	1.20	1.56	<	.05
HC, HH vs HL-H at Series 5	2.62	1.20	2.22	<	.05
HC, HH vs HL-H at Series 6	2.62	1.20	2.45	<	.05

... continued

Table 3:1 continued

Comparison	Error Estimate	*t*- Ratio Denominator	*t* Value	*p*
HC vs HH at Series 3	2.62	0.62	0.14	> .10
HC vs HH at Series 4	2.62	0.62	0.05	> .10
HC vs HH at Series 5	2.62	0.62	1.52	> .05
HC v HH at Series 6	2.62	0.62	1.42	> .05
LC, LL vs HL-L at Series 3	2.62	0.62	0.25	> .10
LC, LL vs HL-L at Series 4	2.62	0.62	-1.16	> .10
LC, LL vs HL-L at Series 5	2.62	0.62	-0.85	> .10
LC, LL vs HL-L at Series 6	2.62	0.62	-0.62	> .10
LC vs LL at Series 3	2.62	0.62	0.96	> .10
LC vs LL at Series 4	2.62	0.62	0.32	> .10
LC vs LL at Series 5	2.62	0.62	0.04	> .10
LC vs LL at Series 6	2.62	0.62	0.24	> .10

Note: HC = High Control, HH = High-High, HL-H = High-Low (High), HH-L = High-Low (Low), LL = Low-Low, LC = Low Control. Denominators of *t*-ratios vary when comparisons are based upon different *n*'s. For conservative *t*-test of between group comparisons, the critical value of $t'_{\alpha/2} = 1.98$.

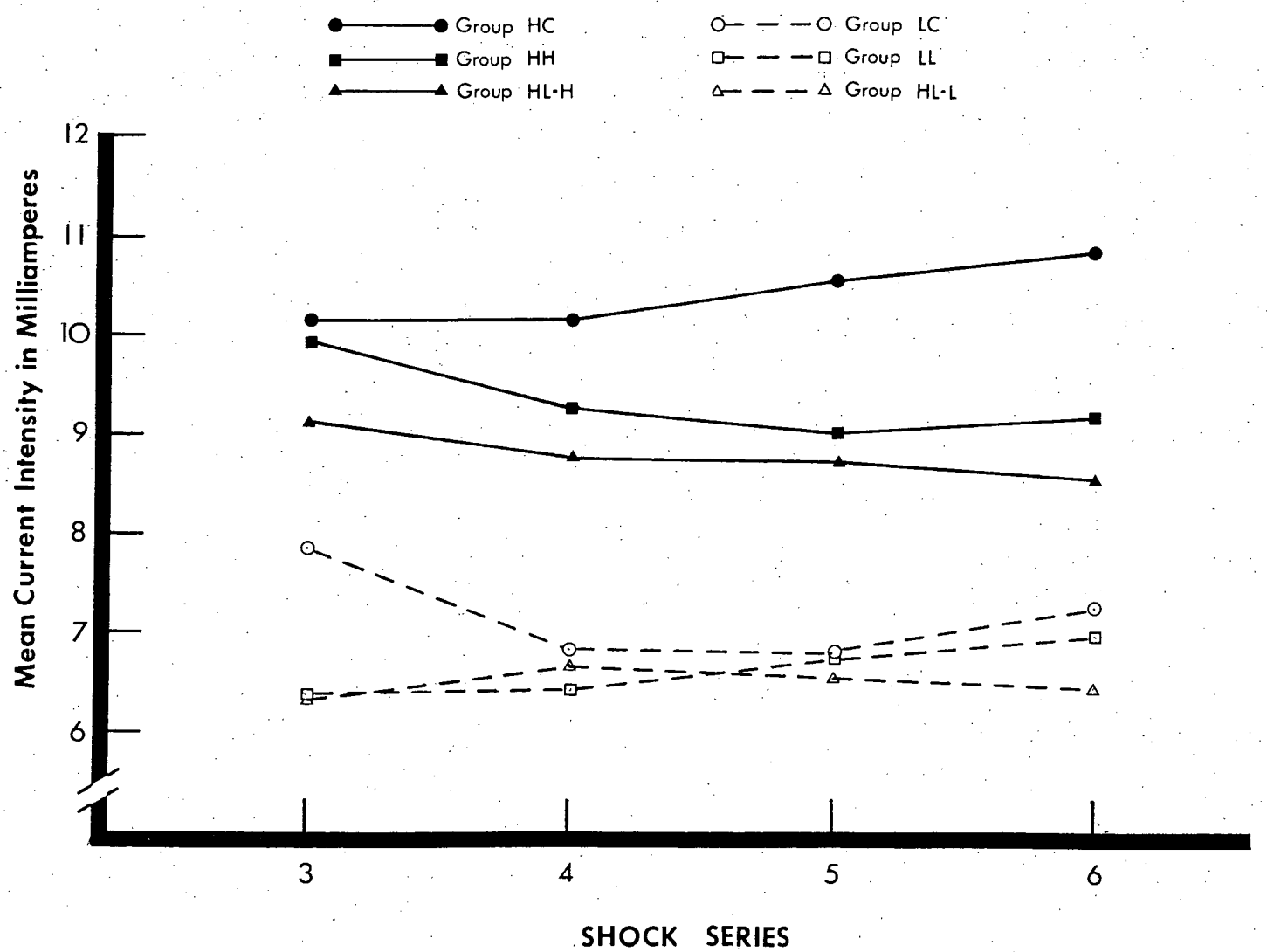
The second set of comparisons was performed at each level of the Series factor during the influence session. Four contrasts were examined at each level: (1) Groups HC and HH vs Group HL-H, (2) Group HC vs Group HH, (3) groups LC and LL vs Group HL-L, (4) groups LC vs group LL. Denominators of t-ratios for each of these contrasts employed the pooled between subject-within error term recommended by Kirk (1968). Cochran and Cox's conservative t (Kirk, 1968) was employed to evaluate the reliability of between-group differences. Examination of the results of these analyses (Table 3:1) indicated that only subjects in group HL-H exhibited significant differences from subjects in groups HC and HH combined. These differences occurred at Series 3, 5, and 6. None of the other between-group comparisons approached statistical reliability.

In sum, the following pattern was observed in the analyses of pain threshold data. Among high pain threshold groups, only those subjects exposed to a subject having a low preassessment threshold exhibited change from the preassessment to the influence session. This change involved an overall decrease in pain threshold. All groups of subjects who exhibited low preassessment pain threshold values exhibited increases in reported pain threshold from the preassessment to the influence session. Only the changes observed in group HL-H resulted in significant between-group differences during the influence session.

Pain tolerance. In Session 2, subjects rated stimuli beyond pain threshold levels to pain tolerance. These data were analyzed via a 6 (Groups) x 4 (Shock Series) ANOVA with repeated measures on the Shock Series factor. The outcome of this analysis indicated that there was a significant Groups effect, $F(5,76) = 7.75$, $p < .01$, and a significant Groups x Shock Series, $F(15,228) = 1.81$, $p < .05$. Mean pain tolerance values for each group

at each level of the Shock Series variable are shown in Figure 3:2. As with pain threshold data, the overall Groups effect was of little interest, since it would largely have reflected the process of selecting subjects from extremes of the distribution of pain threshold scores. Of more interest were comparisons within the high and low pain threshold groups. Orthogonal t-tests were conducted at each level of the Shock Series variable for the following between group comparisons: (1) HC and HH vs HL-H, (2) HC vs HH, (3) LC and LL vs HL-L, (4) LC vs LL. As with the previous analyses, a pooled between-subject-within-subject error term was employed and statistical reliability was assessed at a conservative $t'.05/2$ value of 1.99. None of the orthogonal comparisons exceeded this critical t-value. It was likely, therefore, that the significant interaction derived from a contrast not included in the original set of orthogonal comparisons selected for analysis. Inspection of the means suggested that differences between groups HC and HL-H may have been partially responsible for the significant interaction effect. To evaluate this, means for groups HC and HL-H were compared at each level of the series variable using Tukey's procedure. The error term for these contrasts pooled between-subject and within subject error variance, and significance was evaluated at a conservative q' value for Tukey's test of 2.82 (Kirk, 1968). The only difference between groups that exceeded this value occurred at Shock Series 6 (q = 3.10), where the mean for group HL-H (8.60 mA) was reliably lower than that for group HC (10.80 mA). Inspection of the group means also suggested that at Shock Series 4 the difference between group LC and group HL-L may have been reliable. Evaluation of this possibility by Tukey's test indicated that this was not the case since the obtained q value for this comparison (1.61) failed to exceed the critical value for rejection of the null hypothesis.

Figure 3: 2, Mean intensity of current at the point where subjects terminated each shock series (pain tolerance) during Session 2 for all groups.


Group HC
Group HH
Group HL·H
Group LC
Group LL
Group HL·L
Mean Current Intensity in Milliamperes
12
11
10
9
8
7
6
3
4
5
6
SHOCK SERIES

Results of pain tolerance analyses may be summarized as follows. No between group differences were obtained for any of the low pain threshold groups. Among high pain threshold groups, the only significant effect appeared to derive from subjects in group HL-H exhibiting a progressive decline in pain tolerance values over the 4 shock series of the influence session. This resulted in the mean pain threshold value for group HL-L being significantly lower than that for subjects in group HC at the least shock series. However, subjects in group HL-H could not be differentiated from subjects in group HH on their pain tolerance values. Thus there was evidence that exposure to subjects having a low-preassessment threshold resulted in a decrease in pain tolerance for subjects exhibiting initially high pain threshold values. The effect, however, was not particularly strong, in that it could only be observed during the last shock series.

DISCUSSION

The major impact of the experimental group pairings was evident on the pain threshold measure that the groups were originally differentiated on. Low threshold subjects exhibited a general tendency for their pain threshold levels to increase, regardless of the threshold level of the subject that they were paired with, or whether, in fact, they had a companion at all. High threshold subjects, however, exhibited differential changes depending on group assignment. When subjects with high pretest thresholds were run individually, or with a companion who also exhibited a high pretest threshold, their pain threshold levels remained stable. These two groups could not be differentiated from each other in terms of pain threshold levels during session 2. However, when a subject exhibiting a high pretest pain threshold participated concurrently with a subject having a low pretest threshold, high subjects showed marked and significant reductions in their pain threshold values. Low pretest pain threshold subjects in this group showed increases in pain threshold levels. However, the tendency for painthresholds of all subjects having a low pretest threshold to increase represents strong evidence that being exposed to a high threshold companion was not responsible for this change. Conversely, the differential pattern of change among high pretest threshold subjects provides strong evidence that exposure of high threshold subjects to the behaviour of low threshold subjects was specifically responsible for the threshold reduction observed among high subjects.

The overall outcome of this study was not consistent with the hypothesis of reciprocal influence. Rather, social influence in this setting seemed quite clearly to be unidirectional. Low threshold subjects influenced high threshold subjects to report pain sooner than, it seems, they ordinarily

would have. The behaviour of high threshold subjects, on the other hand, had no demonstrable impact on the behaviour of low threshold subjects. Results of the analysis of pain tolerance data were consistent in this regard; however, the effect was considerably weaker and less clear cut.

The fact that a clear pain-threshold increment resulting from exposure of low-threshold subjects to high threshold subjects was not demonstrated is troublesome, especially in light of the consistently-reported efficacy of modeling procedures in the reduction of avoidance behaviour (Bandura, Blanchard and Ritter, 1969; Bandura, Grusec and Menlove, 1967; Bandura and Menlove, 1968; Geer and Turtletaub, 1967; Bandura, Jeffrey and Wright, 1974; Rachman, 1972). This discrepancy might be accounted for in a number of different ways. For one, it is important to emphasize that while a differential increment in pain threshold among low-threshold subjects exposed to high-threshold subjects was not observed, a general increment among all low-threshold subjects was. The process responsible for this general change may simply have been more powerful than any process activated by exposure to a high threshold subject and may have masked any effect of the latter. Some speculations regarding the process(es) responsible for the general increment among low threshold subjects will be elaborated below. While plausible, this explanation highlights another issue. In spite of the fact that low-threshold subjects exhibited a general increment in pain thresholds the magnitude of this increment was not so great as to elevate the mean of any of the low-threshold groups to the same level as any of the high-threshold groups. While many previous studies have demonstrated that modeling treatments effectively reduce aversively-motivated behavior, it is not always clear that the effect of the treatments are sufficiently powerful that the subjects' behaviours approach normative levels. Thus, modeling may be effective in

reducing avoidance behaviours, but it may not eliminate them.

The plausibility of the "masking" explanation of the outcome of the present study is undermined by the repeated demonstration in previous studies of modeling effects on pain of the remarkably powerful influence of exposure to a tolerant model among unselected groups of subjects. The fact that in the present study selected groups were employed points to another potential explanation of the relative ineffectiveness of exposure to high threshold subjects. Individuals who are particularly reactive to noxious stimulation may simply have uncharacteristically stable response styles that are capable of exhibiting change within relatively narrow bounds. Mischel (1973) in discussing trait concepts pointed out that the demonstrable plasticity and situational specifity of human behaviour calls into question the general utility and validity of such concepts. However in certain extreme cases, notably those characterized as pathological, evidence favors the notion that behavioral styles are relatively stable and general (Mischel, 1973). This extreme-case stability notion suggests that enhanced pain thresholds may have been observed had a midrange group, comprised of subjects exhibiting normative pain threshold levels, been included in the study.

Yet another possible explanation for the present finding springs directly from the fact that relatively pain-intolerant behaviour was clearly a more powerful source of influence than relative tolerance. High threshold subjects, upon being exposed to low-threshold subjects, rather rapidly came to approximate their behaviour. Thus, behaviour of "highs" became less discrepant from the behaviour of "lows" than it would have been had, for example, a tolerant model who adopted a fixed role been employed. This relative power account seems to match the data most closely, and is therefore favorable.

The problem of accounting for the general increment in pain threshold values among all low-threshold groups still remains. As one possibility, a differential anxiety-reduction hypothesis could be advanced, suggesting that low threshold subjects experienced less anxiety during Session 2 than during Session 1. A large number of studies have documented the pain enhancing effects of anxiety and the notion that anxiety-reduction mediates many pain-reducing interventions is well ingrained in the literature (Averill, 1973; Johnson, 1973; Johnson & Leventhal, 1973; Martinez-Urrutia, 1975; Staub & Kellett, 1972; Sternbach, 1968, 1974). However, such an hypothesis seems cumbersome.

Alternatively, appeal can be made to Marks' (1975) account of the critical factors involved in fear-reduction techniques. Marks has provided a formulation suggesting that the critical variable common to the wide variety of techniques effective for fear-reduction is simple exposure to the feared situation. The subjects in the present study had the benefit of prior exposure to the experimental situation when they returned for Session 2. It seems possible that this simple pre-exposure may have accounted for the increase in pain thresholds in Session 2. Since subjects in the high threshold groups were already at the upper extreme of the pain threshold distribution, such an exposure effect may have been eliminated due to the operation of a ceiling effect.

High threshold subjects who participated alone in the second session or concurrently with another high threshold subject, exhibited no changes in their pain threshold levels. It is important to note that these are, in fact, positive findings in that they rule out regression toward the mean as an explanation for other findings in the study. The fact that high-high pairs did not exhibit an elevation in pain threshold or tolerance is likely attri-

butable to a ceiling effect.

The present findings have significant theoretical implications in at least two respects. First, they extend the generality of previous demonstrations of social modeling influences on pain behaviour by showing that naturally-occurring variations in pain behaviour can provide significant sources of influence over the pain behaviour of others. While rigorous control over the roles enacted by models in previous studies was required in order to demonstrate the presence of an effect, it could have been argued that the procedures were sufficiently artificial to question the applicability of the findings to social influence processes in the natural environment. Since naturally-occurring pain behaviour had a significant influence on the behaviour of others, it seems reasonable to speculate that similar processes might operate in natural settings.

Second, the finding of a differential impact of relatively pain intolerant behavior upon relatively tolerant behaviour provides particular support for speculations that social modeling influences play a significant role in the generation of relative intolerance for pain in the natural environment, and quite possibly in the origin of pathological pain behaviour (Craig, 1975, 1978, Fordyce, 1976b). This finding is also consistent with speculations that modeling variables are critical agents in the etiology of other deviant forms of avoidance behavior. The finding that intolerant behaviour is differentially powerful also raises the interesting prospect that modeling, like other forms of learning, is constrained (cf. Hinde and Stevenson-Hinde, 1973).

In spite of the reported high correlation between pain threshold and pain tolerance values using virtually identical stimulation techniques to those employed in the present study (Price and Tursky, 1975), the outcome of the pain tolerance analysis was not nearly as impressive as the outcome of

the pain threshold analysis. High threshold subjects exposed to low threshold subjects exhibited reduced pain tolerance relative to high control subjects, this difference was only evident on the last trial of the influence session. While this finding is consistent with the outcome of the pain threshold analysis, and suggests that the conclusions derived from the latter are generalizable to pain tolerance, the effect was evidently quite weak. Two points must be taken into account in relation to this problem. First, while Price and Tursky (1975) reported a strong relationship between threshold and tolerance measures, the relationship was, of course, not perfect. It might be expected that the error involved in the relationship might be magnified when variables are manipulated in order to investigate modulation of the measures. Second measures of the strength of a relationship tend to take on lower values when extreme groups are employed, as in the present study. It is possible, that the observed outcome reflects, in some way, the employment of extreme groups.

GENERAL DISCUSSION

The foregoing studies have attempted to map more broadly the variety of responses to pain that may be altered as a function of social modeling influences, and to extend the generality of accounts of pain phenomena based on knowledge and theory of social influence processes. Experiment 1 provided evidence supportive of previous claims that exposure to an intolerant social model enhances sensory sensitivity to painful stimuli, while at the same time suggesting that previous conclusions regarding the sensory effects of exposure to a tolerant model need to be restricted. In Experiment 2, a novel dependent variable -- overt expression of pain -- was investigated, and provocative evidence was found suggesting that social influences are capable of producing alterations in behaviour that are critical social discriminative stimuli. Experiment 3 demonstrated that modeling effects are observable even when subjects exhibiting predispositions toward particular kinds of pain behaviour, rather than programmed confederates, are employed as models. Further, it appeared that in the impact of conflicting response styles, interpersonal influence, rather than being reciprocal, was unidirectional, and that intolerant behaviour was considerably more powerful than tolerant behaviour. The studies, taken as a whole, give added impetus to the claim that social events are critically implicated in fundamental aspects of pain. Simultaneously, the studies highlight a number of issues that warrant further discussion.

Experimental pain research has experienced an enormous growth within the past decade. In the process of this expansion, two groups of researchers have emerged that can be differentiated on the basis of the types of subject and the type of dependent variable they employ. Researchers who employ nonhuman subjects tend to be interested in the anatomical structures and physiological

processes subserving pain, and naturally base their conclusions on the overt behaviour of the organism. Researchers who employ human subjects examine a wider range of influences, but they tend to be interested in exogenous influences on pain. Their dependent variables are almost exclusively derived from subjects' reports. Both groups make equivalent claims regarding their ability to draw inferences about the processes underlying pain responses and pain modulation. The second experiment in the present series was unusual among studies of pain in humans in that it was based upon observations of subjects' overt behaviour. The technique can readily be adapted to most pain studies and appears to offer a great deal of promise for evaluating pain-modulation procedures.

Another important issue raised by the present studies is that of the inconsistent interrelationships exhibited by different measures of pain. The word "pain" subsumes a diversity of exceedingly complicated sensory and behavioural phenomena that defy oversimplified interpretations. Nature does not show an overwhelming degree of respect for Rollman's (1977) caricature of the clinician who wishes a simple definitive answer to the question, "Has pain been reduced?" In the present series of investigations, those that employed the subject's verbal behaviour as a source of information about pain modulation suggested that exposure to an intolerant model was a particularly powerful source of influence. At the same time, data derived from observations of expressive behaviour suggested that an impact of greater magnitude was associated with exposure to a tolerant model.

An important, related question raised by the data presented in this report concerns the nature of the relationship between the observed changes in behaviour and the sensory events that contribute to them. The common assumption that vocal reports provide, under appropriate circumstances, fairly direct

access to private experiences is apparent in much pain research. However, the reasons why vocal behaviour should provide any more adequate access to such experiences than other types of behaviour are not apparent. There seems to be no particular reason that, for example, expressive behaviour can not be assumed to provide equally adequate access to private experiences. These questions are of substantial importance in attempting to account for the outcomes of Experiments 1 and 2 in the present series. In Experiment 1, the evidence based on subjects' vocal reports, indicated that exposure to an intolerant model increased sensory sensitivity to painful stimulation, while exposure to a tolerant model had no apparent impact on sensitivity. In Experiment 2, the evidence, based on observation of the expressive behaviour of the subjects in Experiment 1 provoked quite different conclusions. While for a number of reasons inferences about the influence of intolerant modeling present interpretive difficulties, the implication of Experiment 2 was that tolerant modeling was associated with expressive behaviour indicative of reduced sensitivity to the stimulation. Which source of information -- vocal report or expressive behaviour -- provides the most appropriate basis for drawing inferences about sensory sensitivity?

It is difficult to accept the notion that data from different measures that are presumably mediated by similar processes can under many circumstances exhibit such a lack of correspondence. Lately, some interest has been directed toward examining relationships among private experiences, expressive and vocal behaviour and physiological processes (Craig & Prkachin, 1978). Kleck et. al., (1976) have proposed an account, and marshalled some supportive evidence suggesting that private experiences of pain may be mediated by changes in expressive behaviour. Similarly, Bandler, Madaras, and Bem (1968) have provided evidence that pain perception may largely reflect the operation of

processes that first affect the individual's overt behaviour. While the specific details of their model need not be adhered to, it is interesting to speculate that social influence procedures exert their fundamental and most immediate impact on overt social behaviour and that changes in sensory experiences may follow these primary changes at some delay. This would suggest that the temporal constraints involved in Experiment 1 and previous SDT analyses of modeling effects on pain, provided an insufficient opportunity to observe the ultimate sensory effects of social influences. This proposal while lacking empirical support, makes sense in that natural socialization processes implicated in pain modulation operate over a long term, and their effects are quite likely cumulative over time. Other support for this proposal derives from the apparent success of behaviourally-based programs for the remediation of chronic pain problems which operate over extended periods of time, and emphasize long term alteration of contingencies operative in the natural familial environments of patients (Fordyce, 1976b).

This proposal is also consistent with some of Skinner's attempts to explain how environmental events can come to exert an influence upon private experiences (Skinner, 1945; 1957).

The lack of a significant pain threshold decrement among subjects exposed to an intolerant model in Experiment 1 might be accounted for by reference to the outcome of Experiment 3. Both experiments involved assessment of pain thresholds in a pretest and an influence session, and in Experiment 3 it was observed that subjects exhibiting naturally low pain thresholds tended, upon reassessment to show an elevation in thresholds. While Experiment 1 employed unselected groups, it is possible that a significant proportion of subjects in the intolerant group may have exhibited the same tendency as that observed among low threshold subjects in Experiment 3. This outcome would, of course,

have masked any modulating effects attributable to the intolerant modeling. This outcome among intolerant group subjects in Experiment 1 may have been a by product of the use of a repeated sessions procedure.

A final point is in order concerning the apparent unidirectionality of influence in Experiment 3. While it was clear that, within the constraints of the experimental procedures, relative pain intolerance was the more powerful source of influence, it is likely that an exact analog of naturally-occurring social influence processes was not created. As was noted earlier, communications to the effect that pain is being experienced represent imperative social stimuli. Their effects on the behavior of others quite reasonably would be expected to be rapid and powerful. Relatively tolerant behaviour, on the other hand, is likely to be more delayed in its impact. The outcome of this experiment, then, may reflect temporal constraints on the interpersonal effects of tolerant and intolerant behaviour. It is not unreasonable, then, to speculate that a more extended period of concurrent exposure to one another of subjects exhibiting conflicting response styles might have demonstrated a greater degree of influence resulting from exposure to relatively pain tolerant behaviour.

REFERENCE NOTES

1. Craig, K.D. Social modeling influences on pain experience and behaviour. Paper presented at the Symposium "Psychology and Pain Control", Annual Convention of the American Psychological Association, Washington, D.C., 1976.

2. Craig, K.D. and Ward, L.M. Social modeling influences on the discriminability of painful stimuli: A sensory decision analysis. Unpublished manuscript, University of British Columbia.

REFERENCES

Apley, J. & Naish, N. Recurrent abdominal pains: A field survey of 1000 school children. Archives of Disease in Childhood, 1958, 33, 165-170.

Averill, J.R. Personal control over aversive stimuli and its relationship to stress. Psychological Bulletin, 1973, 80, 286-303.

Bandura, A. Principles of Behaviour modification. New York: Holt, Rinehart, & Winston, 1969.

Bandura, A. The self-system in reciprocal determinism. American Psychologist, 1978, 33, 344-358.

Bandura, A. Psychotherapy based on modeling principles. In A.E. Bergin & S.L. Garfield (Eds.), Handbook of psychotherapy and behaviour change. New York: Wiley, 1971.

Bandura, A., Blanchard, E.B., and Ritter, B. The relative efficacy of desensitization and modeling approaches for inducing behavioural, affective, and attitudinal changes. Journal of Personality and Social Psychology, 1969, 13, 173-199.

Bandura, A. Social learning theory, Englewood Cliffs, N.J.: Prentice-Hall, 1976.

Bandura, A., Grusec, J.E., & Menlove, F.L. Vicarious extinction of avoidance behaviour. Journal of Personality and Social Psychology, 1967, 5, 449-455.

Bandura, A., Jeffrey, R.W., & Wright, C.L. Efficacy of participant modeling as a function of response induction aids. Journal of Abnormal Psychology, 1974, 83, 56-64.

Bandura, A., & Walters, R.H. Social Learning and Personality Development, New York: Holt, Rinehart, and Winston, 1963.

Bandler, R.J., Madaras, G.R., & Bem , D.J., Self-observation as a source of pain perception. Journal of Personality and Social Psychology, 1968, 9, 205-209.

Beecher, H.K. Measurement of subjective responses: Quantitative effects of drugs. New York: Oxford University Press, 1959.

Bell, R.Q., A reinterpretation of the direction of effects in studies of socialization. Psychological Review, 1968, 75, 81-95.

Berger, S.M., Conditioning through vicarious instigation. Psychological Review, 1962, 69, 450-466.

Bleda, P.R., Empathy, sympathy, and altruism. Journal Supplement Abstract Service, Catalogue of Selected Documents in Psychology, 1976, 6 (9), (Ms. No. 1180).

Bonica, J.J. & Albe-Fessard, D. Advances in pain research and therapy, Vol.1. Proceedings of the First World Congress on Pain. New York: Raven, 1976.

Chapman, C.R., Letter to the editor. Anesthesiology, 1976, 44, 358-359.

Chapman, C.R., Sensory decision theory methods in pain research: A reply to Rollman. Pain, 1977, 3, 295-305.

Chapman, C.R., Gehrig, J.D., & Wilson, M.E., Acupuncture and 33% nitrous oxide modify detectability of painful stimuli. Anesthesiology, 1975, 42, 532-537.

Chapman, C.R., Murphy, J.M., & Butler, S.H., Analgesic strength of 33% nitrousoxide: A signal detection theory evaluation. Science, 1973, 179, 1246-1248.

Chaves, J.F., and Barber, T.X. Cognitive strategies, experimenter modeling, and expectation in the attenuation of pain, Journal of Abnormal Psychology, 1974, 83, 356-363.

Clark, W.C. Sensory-decision theory analysis of the effects of a placebo on the ariterion for pain and thermal sensitivity (d'). Journal of Abnormal Psychology, 1969, 74, 363-371.

Clark, W.C. Pain sensitivity and the report of pain: An introduction to sensory decision theory. Anesthesiology, 1974, 40, 272-287.

Clark, W.C., & Dillon, D.J., Signal detection theory analysis of binary decisions and sensory intensity ratings to noxious thermal stimuli. Perception and Psychophysics, 1973, 13, 491-493.

Clark, W.C., & Mehl, L. Signal detection theory procedures are not equivalent when thermal stimuli are judged. Journal of Experimental Psychology, 1973, 97, 148-153.

Craig, K.D., Social disclosure, coactive peer companions and social modeling determinants of pain communications. In press, Canadian Journal of Behavioural Science, 1978 a.

Craig, K.D., Social modeling influences on pain. R.A. Sternbach (Ed.), The psychology of pain. New York: Raven, 1978b. in press.

Craig, K.D., & Best, J.A. Perceived control over pain: Individual differences and situational determinants. Pain, 1977, 3, 127-135.

Craig, K.D., Best, H., & Best, J.A. Self-monitoring sensory and affective dimensions of pain experiences. In press, Journal of Consulting and Clinical Psychology, 1978.

Craig, K.D., Best, H., & Reith,G., Social determinants of reports of pain in the absence of painful stimulation. Canadian Journal of Behavioural Science, 1974, 6, 169-177.

Craig, K.D., Best, H., & Ward, L.M. Social modeling influences on psychophysical judgments of electrical stimulation. Journal of Abnormal Psychology, 1975, 84, 366-373.

Craig, K.D., and Coren, S. Signal detection analyses of social modeling influences on psychophysical judgments of electrical stimulation. Journal of Psychosomatic Research, 1975,19, 105-112.

Craig, K.D., and Lowery, H.J. Heart-rate components of conditioned vicarious autonomic responses. Journal of Personality and Social Psychology, 1969, 11, 381-387.

Craig, K.D., and Niedermayer,H. Autonomic correlates of pain thresholds influenced through social modeling. Journal of Personality and Social Psychology. 1974, 29, 246-252.

Craig, K.D. & Prkachin, K.M. Social modeling influences on sensory-decision theory and psychophysiological indexes of pain. In press, Journal of Personality and Social Psychology, 1978.

Craig, K.D., and Weiss, S.M. Verbal reports of pain without noxious stimulation. Perceptual and Motor Skills, 1972, 34, 943-948.

Crockett, D.J., Prkachin, K.M., & Craig, K.D. Factors of the language of pain in patient and volunteer groups. Pain, 1977, 4, 175-182.

Dennis, S.G., & Melzack, R. Pain-signaling systems in the dorsal and ventral spinal cord. Pain, 1977, 4, 97-132.

Ekman, P. Differential communication of affect by head and body cues. Journal of Personality and Social Psychology, 1965, 2, 726-735.

Ekman,P., & Friesen, W.V. Nonverbal leakage and clues to deception. Psychiatry, 1969, 32, 88-106.

Ekman, P., & Friesen, W.V. Detecting deception from the body or face. Journal of Personality and Social Psychology, 1974a, 29, 288-298.

Ekman, P., & Friesen, W.V. Nonverbal behaviour and psychopathology. In R.J. Friedman, & M.M. Katz (Eds.), The psychology of depression: Contemporary theory and research. Washington, D.C.: V.H. Winston, 1974b.

Endler, N., & Okada, M.A. A multidimensional measure of trait anxiety: The S-R Inventory of General Trait Anxiousness. Journal of Consulting and Clinical Psychology, 1975, 43, 319-329.

Epley, S.W. Reduction of the behavioural effects of aversive stimuli by the presence of companions. Psychological Bulletin, 1974, 81, 271-283.

Fagerhaugh, S.Y. Pain expression and control on a burn control unit. Nursing Outlook, 1974, 22, 645-650.

Fordyce, W.E. Behavioural concepts in chronic pain and illness. In P.O. Davidson (Ed.), The behavioural management of anxiety, depression, and pain. New York: Brunner Mazel, 1976 a.

Fordyce, W.E. Behavioural methods for chronic pain and illness. St.Louis: C.V. Mosby, 1976 b.

Fordyce, W.E., Fowler,R.S.,Jr. & DeLateur, B.J., An Application of Behaviour Modification technique to a problem of chronic pain. Behaviour Research and Therapy, 1968, 6, 105-107.

Fordyce, W.E., Fowler, R.S.,Jr., Lehmann, J.F., Delateur, B.J., Sand, P.L. & Trieschmann, R.B., Operant Conditioning in the Treatment of Chronic Pain. Archives of Physical Medicine and Rehabilitation, 1973, 54, 399-408.

Geer, J.H. & Turteltaub, A., Fear reduction following observation of a model. Journal of Personality and Social Psychology, 167, 6, 327-331.

Gentry, W.D., Schows, W.D., & Thomas, M. Chronic Low back pain: A psychological profile. Psychosomatics, 1974, 15, 174-177.

Green, D.M. & Swets, J.A. Signal detection theory and psychophysics. New York: Wiley, 1966.

Grossberg, J.M. & Grant, B.F. Clinical Psychophysics. Unpublished manuscript, San Diego State University, 1976.

Hall, W. Psychological processes in pain perception: The prospect of a signal detection theory analysis. Unpublished Doctoral Dissertation, School of Psychology, The University of New South Wales, 1977.

Hardy, J.D., Wolff, H.G., & Goodell, H. Pain sensations and reactions. Baltimore: Williams & Wilkins, 1952.

Hayes, R.L., Bennett, G.J., & Mayer, D.J. Acupuncture pain, and signal detection theory. Science, 1975, 189, 65-66.

Hilgard, E.R. A quantitative study of pain and its reduction through hypnotic procedures. Proceedings of the National Academy of Sciences, 1967, 57, 1581-1586.

Hilgard, E.R. Pain as a puzzle for psychology and physiology. American Psychologist, 1969, 24, 103-113.

Hilgard, E.R., Ruch, J.C., Lange, A.F., Lenox, J.R., Morgan,A.H., & Sachs, L.B. The psychophysics of cold pressorpain and its modification through hypnotic suggestion. American Journal of Psychology, 1974, 87, 17-31.

Hinde, R.A., & Stevenson-Hinde, J. Constraints on learning: Limitations and predispositions. New York: Academic Press, 1973.

Johnson, J.E. Effects of accurate expectations about sensations on the sensory and distress components of pain. Journal of Personality and Social Psychology, 1973, 27, 361-375.

Johnson, J.E., & Leventhal, H. Effects of accurate expectations and behavioural instructions on reactions during a noxious medical examination. Journal of Personality and Social Psychology, 1974, 29, 710-718.

Kanfer, F.H., & Grimm, L.G. The future of behaviour modification. In W.E. Craighead, A.E. Kardin, & M.J. Mahoney (Eds.), Behaviour modification: Principles, issues and applications. Boston, Houghton-Mifflin, 1976.

Kirk, R.E. Experimental design: Procedures for the behavioural sciences: Belmont, California: Books/Cole, 1968.

Kleck, R.E., Vaughan, R.C., Cartwright-Smith, J., Vaughan, K.B., Colby, C.F., & Lanzetta, J.T. Effects of being observed on expressive, subjective, and physiological responses to painful stimuli. Journal of Personality and Social Psychology, 1976, 34, 1211-1218.

Kraut, R.E. Verbal and nonverbal cues in the perception of lying. Journal of Personality and Social Psychology, 1978, 36, 380-391.

Krebs, D.L. Empathy and altruism. Journal of Personality and Social Psychology, 1975, 32, 1134-1146.

Lanzetta, J.T., Cartwright-Smith, J., & Kleck, R.E. Effects of nonverbal dissimulation on emotional experience and autonomic arousal. Journal of Personality and Social Psychology, 1976, 33, 354-370.

Lambert, W.E., Libman, E., & Poser, E.G. The effect of increased salience of group membership on pain tolerance. Journal of Personality, 1960, 28, 350-357.

Liebeskind, J.C., & Paul, L.A. Psychological and physiological mechanisms of pain Annual Review of Psychology, 1977, 28, 41-60.

Lloyd, M.A., and Appel, J.B. Signal detection theory and the psychophysics of pain: An introduction and review. Psychosomatic Medicine 1976, 38, 79-94.

Lloyd, M.A., & Wagner, M:K. Acupuncture analgesia and radiant-heat pain: A signal-detection analysis. Anesthesiology, 1976, 44, 147-150.

Marks, I. Behavioural treatments of phobic and obsessive-compulsive disorders: A critical appraisal. In M. Hersen, R.M.Eisler, & P.M. Miller (Eds.), Progress in behaviour modification, Vol.1 New York: Academic Press, 1975.

Martinez-Urrutia, A. Anxiety and pain in surgical patients. Journal of Consulting and Clinical Psychology, 1975, 43, 437-442.

Mayer, D.J. In S.H. Snyder & S. Matthyse. Opiate receptor mechanisms. Neuroscience Research Program Bulletin, 1975, 13 (1)

Mayer, D.J. & Price, D.D. Central nervous system mechanisms of analgesia. Pain, 1976, 2, 379-404.

Mayer, D.J., Price, D.D., Berber,J., & Raffi, A. Acupuncture hypalgesia: Evidence for activation of a central control system as a mechanism of action. In J.J. Bonica & D. Albe-Fessard (Eds), Advances in pain research and therapy, Vol.1 Proceedings of the First World Congress on Pain, New York: Raven, 1976.

McBurney, D.H. Acupuncture, pain and signal detection theory. Science, 1975, 189, 66.

McNicol, D. A primer of signal detection theory. London: George Allen and Unwin, 1972.

Melzack, R. The puzzle of pain, Hamondsworth, Middlesex, England: Penguin, 1973.

Melzack, R., & Casey, K.L. Sensory, motivational, and central control determinants of pain: A new conceptual model. In D. Kenshalo (Ed.) The skin senses. Springfield, Illinois: Charles C. Thomas, 1968.

Melzack, R. & Torgerson, W.S. On the language of pain. Anesthesiology, 1971, 34, 50-59.

Melzack, R. & Wall, P.D. Pain mechanisms. A new theory. Science, 1965, 150, 971-979.

Melzack, R., and Wall, P.D. Psychophysiology of pain. The International Anesthesiology Clinics, 1970, 8, 3-34.

Mischel, W. Toward a cognitive social learning reconceptualization of personality. Psychological Review, 1973, 80, 252-283.

Neufeld, R.W.J., & Davidson, P.O. The effects of vicarious and cognitive rehearsal on pain tolerance. Journal of Psychomatic Research, 1971, 15, 329-335.

Neufeld, R.W.J., & Davidson, P.O. Scaling of the subjective stress scale with a sample of university undergraduates. Psychological Reports, 1972, 31, 821-822.

Oster, J. Recurrent abdominal pain, headache and limb pains in children and adolescents. Pediatrics, 1972, 50, 429-436.

Pastore, R.E. & Scheirer, C.J. Signal detection theory; Considerations for general application. Psychological Bulletin, 1974, 81, 945-958.

Pollack, I., Norman, D.A. & Galanter, E. An efficient non-parametric analysis of recognition memory. Psychonomic Science, 1964, 1, 327-328.

Price, K.P., & Tursky, B. The effect of varying stimulus parameters on judgments of nociceptive electrical stimulation. Psychophysiology, 1975, 12, 663-666.

Rachman, S. Clinical application of observational learning, imitation, and modeling Behaviour Therapy, 1972, 3, 379-397.

Rollman, G. Signal detection theory measurement of pain: A review and critique. Pain, 1977, 3, 187-211.

Skinner, B.F. Science and human behaviour. New York: MacMillan, 1953.

Skinner, B.F. Verbal behaviour. New York: Appleton-Century-Crofts, 1957.

Skinner, B.F. About behaviourism. New York: Alfred A. Knopf, 1974.

Staub, E. & Kellett, D.S. Increasing pain tolerance by information about aversive stimuli. Journal of Personality and Social Psychology, 1972, 21, 198-302.

Sternbach, R.A. Pain: A psychophysiological analysis. New York: Academic Press, 1968.

Sternbach, R.A. Pain Patients: Traits and treatment. New York: Academic Press, 1974.

Sternbach, R.A., & Tursky, B. Ethnic differences among housewives in psychophysical and skin potential responses to electric shock. Psychophysiology, 1965, 1, 241-246.

Stevens, S.S. Psychophysics. New York: Wiley, 1975.

Szasz, T.S. The psychology of persistent pain: A portrait of l'homme douloureux. In A. Soulairac, J. Cahn, & J. Charpentier (Eds.), Pain. New York: Academic Press, 1968.

Teghtsoonian, R. On the exponents in Stevens' law and the constant in Ekman's law. Psychological Review, 1971, 78, 71-80.

Thompson, S.C. Detection of social cues: A signal detection theory analysis. In press. Personality and Social Psychology Bulletin, 1978.

Tursky, B. Physical, physical and psychological factors that affect pain reaction to electric shock. Psychophysiology, 1974, 11, 95-112.

Tursky, B., & Sternbach, R.A. Further physiological correlates of ethnic differences in responses to shock. Psychophysiology, 1967, 4, 67-74.

Tursky, B., Watson, P.O., & O'Connell, D.M. A concentric shock electrode for pain stimulation. Psychophysiology, 1965, 1, 196-198.

Waxer, P. Nonverbal cues for depression. Journal of Abnormal Psychology, 1974, 83, 319-322.

Waxer, P.H. Nonverbal cues for anxiety: An examination of emotional leakage. Journal of Abnormal Psychology, 1977, 86, 306-314.

Weisenberg, M. Pain: Clinical and experimental perspectives. St. Louis: C.V. Mosby, 1975.

Weisenberg, M. Pain and pain control. Psychological Bulletin, 1977, 84, 1008-1044

Zborowski, M. People in pain. San Francisco: Jossey-Bass, 1969.

Appendix A: Psychometric data from Experiment 1.

This appendix presents analyses of data derived from two questionnaires administered to subjects in Experiment 1: the Subjective Stress Scale (SSS), and the McGill Pain Questionnaire (MPQ). These questionnaires are presented in Appendix C.

The SSS was administered both before and after each session in Study 1. Scale score values for each administration were determined from Neufeld and Davidson's (1972) table, and entered into a 3 (Groups) X 2 (Sessions) X 2 (Administrations: pre- and post) ANOVA design. The only significant effect to emerge from this analysis was that for Sessions, F (1,32) = 15.45, p < .01. SSS scale-score values declined from a mean of 1.14 during Session 1 to a mean of 0.62 during Session 2. Thus, subjects reported lower levels of subjectively appraised stress during Session 2 than they did during Session 1.

The MPQ was administered at the end of each session in Experiment 1. This questionnaire has two components: (1) an adjective checklist portion that contains 20 categories of 2 to 6 words descriptive of various qualities of pain, and (2) a Pain Intensity Rating portion that requires the respondent to indicate the intensity of his or her pain on a 5-point scale ranging from mild to excruciating. Subjects were instructed to use the highest current they had accepted as their reference for responding to each question.

Melzack and Torgerson (1971) and Melzack (1975) have rationally subdivided the adjective checklist portion into 3 dimensions: termed Sensory, Affective, and Evaluative. Crockett, Prkachin, and Craig (1977) conducted a factor analysis of the MPQ adjectives in groups of low back pain patients and volunteers exposed to experimental pain. They extracted 5 factors from their analysis, named: (I) Immediate Anxiety, (II) Perception of Harm, (III) Somes-

thetic Pressure, (IV) Cutaneous Sensitivity, and (V) Sensory Information.

Analyses were conducted on the scale value of the Pain Intensity Rating, rank scores for Melzack's rationally-defined dimensions, and factor scores for Crockett *et. al.*'s empirically-derived factors. All analyses used a 3 (Groups) X 2 (Session) ANOVA design.

No significant differences emerged on Pain Intensity ratings. Analyses of the rationally-derived factors revealed no significant affects on the Sensory and Affective dimensions. On the Evaluative dimension, a significant Sessions effect emerged, F (1,32) = 10.63, $p < .01$. The mean rank score on this measure increased from 1.06 in Session 1 to 1.89 in Session 2. According to Melzack and Torgerson (1971, p. 51) this dimension is descriptive "of the subjective overall experience of the total experience of pain." It is not unreasonable that this measure should have increased in Session 2, since the session was very long and involved extended experience with high intensity shocks.

In the analysis of Crockett *et. al*'s (1977) factors a significant Sessions effect occurred on Factor III (Somesthetic Pressure), F (1,32) = 7.29, $p < .01$. Factor scores increased from a mean of 1.36 in Session 1 to 1.97 in Session 2.

Appendix B: Consent forms.

CONSENT FORM: EXPERIMENT 1

Experimental Participation Consent Form

Name of the Subject: _____

I hereby consent to participate in the study as described by

_____ to me at this time. I

understand that the risks to me as a subject are minimal.

I further acknowledge that I have been advised that I can withdraw from

participation in the project at any time.

Signature: _____

Date: _____

Experimental Participation Consent Form,

Name of the Subject: _____

I hereby consent to participate in the study as described by

_____ to me at this time. I

understand that the risks to me as a subject are minimal.

I further acknowledge that I have been advised that I can withdraw from

participation in the project at any time.

Signature: _____

Date: _____

VIDEOTAPE PLAYBACK CONSENT FORM

I, _____, do hereby give my consent to _____ for the showing of videotapes taken of myself during my participation in the experiment entitled,"Social modeling influences on expressive and psychophysical components of pain response," to:

1. other people participating as subjects in the aforementioned experiment,
2. people involved in the analysis of data collected during the experiment,
3. professional audiences in the context of research colloquia or similar scientific purposes.

I understand that the above three items are all that I have given consent to, and that, outside of these constraints, the records taken of me will be kept strictly confidential.

_____

Signature of participant

_____

Signature of experimenter

_____

Date

CONSENT FORM: EXPERIMENT 3

EXPERIMENTAL PARTICIPATION CONSENT FORM

Name of the subject:_____

I hereby consent to participate in the study as described by

_____ to me at this time. I

understand that the risks to me as a subject are minimal.

I further acknowledge that I have been advised that I can withdraw from participation in the project at any time. I also acknowledge that I have seen my physician within the past year.

Signature:_____

Date:_____

Appendix C: Questionnaires administered in Experiment 1.

1. Subjective Stress Scale

2. McGill Pain Questionnaire

SUBJECTIVE STRESS SCALE

Pick only one word of the following list which best describes how you feel at this moment.

Wonderful

Steady

Comfortable

Fine

Indifferent

Didn't Bother Me

Timid

Unsteady

Unsafe

Nervous

Worried

Frightened

Panicky

Scared Stiff

MCGILL PAIN QUESTIONNAIRE

Please answer the following two questions:

1. What did your pain feel like when you received the most intense shock?

Some of the words below describe the pain you experienced. Circle ONLY those words that best describe it. Leave out any category that is not suitable. Use only a single word in each appropriate category -- the one that applied best.

1	2	3	4	5
Flickering	Jumping	Pricking	Sharp	Pinching
Quivering	Flashing	Boring	Cutting	Pressing
Pulsing	Shooting	Drilling	Lacerating	Gnawing
Throbbing		Stabbing		Cramping
Beating		Lancinating		Crushing
Pounding				

6	7	8	9	10
Tugging	Hot	Tingling	Dull	Tender
Pulling	Burning	Itchy	Sore	Taut
Wrenching	Scalding	Smarting	Hurting	Rasping
	Searing	Stinging	Aching	Splitting
			Heavy	

11	12	13	14	15
Tiring	Sickening	Fearful	Punishing	Wretched
Exhausting	Suffocating	Frightful	Gruelling	Blinding
		Terrifying	Cruel	
			Vicious	
			Killing	

16	17	18	19	20
Annoying	Spreading	Tight	Cool	Nagging
Troublesome	Radiating	Numb	Cold	Nauseating
Miserable	Penetrating	Drawing	Freezing	Agonizing
Intense	Piercing	Squeezing		Dreadful
Unbearable		Tearing		Torturing

2. How strong was the most intense pain?

The following 5 words represent pain of increasing intensity.

1	2	3	4	5
Mild	Discomforting	Distressing	Horrible	Excruciating

Write the number of the most appropriate word in the space beside the question.

Which word describes the shock at its worst? _____