Using Differential Outcome to Teach Medication Discriminations to Head Injured Adults

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USING DIFFERENTIAL OUTCOME TO TEACH MEDICATION DISCRIMINATIONS TO HEAD INJURED ADULTS

by

Scott C. Votava

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the requirements for the Degree of Master of Arts
Department of Psychology

Western Michigan University
Kalamazoo, Michigan
April 1994
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I would like to acknowledge the people who helped me complete this thesis. The following are a few of the people who contributed to the completion of this thesis. To the members of my committee, Dr. R. Wayne Fuqua, Dr. Jack Michael and Dr. Neil Kent, I offer my gratitude for providing on-going learning opportunities despite my continuous delays. To my friend Dr. George Thompson, I would like to extend my thanks for continuously prompting and praising of even my smallest accomplishments. To my wife Connie who continuously reminded me that I needed to “finish” and did so with utmost kindness. Finally, to my mother and father, Katey and James Votava, for their support of my decision to enter psychology as a field of study.

Scott C. Votava
USING DIFFERENTIAL OUTCOME TO TEACH MEDICATION DISCRIMINATIONS TO HEAD INJURED ADULTS

Scott C. Votava, M.A.
Western Michigan University, 1994

In attempt to replicate the DOE in teaching medication discriminations, the efficiency of differential outcomes and nondifferential outcomes procedures was compared. Additionally, the effects of the differential outcome procedures and nondifferential outcomes procedures upon generalization probes to novel medications were investigated. Finally, the effects of differential and nondifferential outcome procedures on probes to real medications were investigated. The results showed the differential outcome procedure employed produced the desired discrimination more rapidly than the nondifferential outcome procedure. No conclusive statement can be made regarding data obtained in generalization probes or in probes with real medications.
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INTRODUCTION

Epidemiological data from the United States population indicates traumatic brain injury effects 200 people in every 100,000 in each year. Additionally 44,000 of those brain injuries will be moderate to severe (Kraus, et al., 1984). The deficits incurred by brain injured individuals may vary from skill specific, as in the case with focal injuries, to multiple skills as is the case with injuries producing more generalized trauma. Paralysis, blindness, seizures, language deficits, and decreased ability for new learning are among the problems experienced by the individual surviving a head injury (Goldstein & Ruthven, 1983). Functional deficits in grooming and hygiene, preparing meals, feeding, using transportation, and monitoring health result from disruption of the above skill areas (Rosenthal, 1983). The ranges of deficits noted, among others, pose significant barriers to regaining independence as brain injury survivors attempt to establish functioning in their home communities. As a result, rehabilitation professionals are challenged to develop effective and efficient techniques to help brain injury survivors relearn old skills and learn new skills to help compensate for irreversible deficits.

For individuals with severe physical and neurological impairments, returning the person to pre-injury status may not be possible. In these instances, learning new skills to compensate for acquired deficits is indicated. Some new skills such as feeding oneself through a gastric tube require the development and
refining of a completely new set of behaviors. Other skills such as self-medication may require that some previous skill be under the control of very specific stimuli (i.e., specific medications). For example, when driving may no longer be possible, discrimination of correct public transportation routes allows independence. When individuals with acquired seizure disorders or health problems require life saving medication regimens, discrimination of correct medication is crucial in self-medication.

Goldstein & Ruthven (1983) and Rosenthal (1983) describe that head injured individuals often show decreased ability for learning new behavior. Given this difficulty, technologies for teaching new discriminated responses have apparent rehabilitative value for returning these individuals to their home communities with optimal independence. Much technology has been developed for skill development in the disabled populations. Examples of existing teaching technology include prompting (e.g., Wolery and Gast, 1984), chaining (e.g., Azrin, 1976) and fading (Browder, Morris & Snell, 1981). Another technology for teaching comes from study of the differential outcome effect (Peterson & Trapold, 1980).

Differential Outcome Defined

The differential outcome effect (DOE) refers to a reliable phenomenon whereby organisms develop discriminations between stimulus objects more quickly and more accurately when correct responding produces a unique (correlated) outcome than when correct responding to stimulus objects produces common
(uncorrelated) outcomes. When teaching a discrimination between a penny and a
dime, for example, the two coins may be presented simultaneously. On some
trials, the person is asked to point to the penny, on other trials the person is asked
to point to the dime. A standard differential reinforcement procedure would
produce verbal praise for correct responses to either the penny or the dime. The
outcome is not correlated specifically with one or the other of the stimulus objects.
A differential outcome procedure would produce verbal praise for correct responses
to the dime and a pat on the shoulder for correct responses to the penny. Thus,
correct responses to each stimulus object have a different, or differential, outcome.
The word “outcome” is used because quicker discriminations have been found
when not only using correlated rewards (reinforcers) but also when a reinforcer
follows correct responses to one stimulus object and a tone follows correct
responses to the other stimulus object (e.g., Fedorchak & Bolles, 1986; Peterson, et
al., 1980).

Differential outcome effects have been observed with nonhumans (e.g.,
Brodigan & Peterson, 1976; Delong & Wasserman, 1981; Fedorchek & Bolles,
1986) and with human subjects including autistic children (e.g., Hewett, 1965; &
Stark, et al., 1968) and with mentally retarded individuals (e.g., Jansen & Guess,
1978; Litt & Schreibman, 1981; Saunders & Sailors, 1979; Stark, Giddon &
Meisel, 1968). Thus, the DOE has been replicated across a wide variety of human
and nonhuman subjects. In contrast to the above studies, Dube, Rocco & McIvane
(1989) failed to replicate the DOE using a delayed match to sample procedure
using mentally retarded men as subjects. These authors provide several plausible explanations for the failure of replication. When comparing their results to findings with nonhumans, Dube, et al. (1989) suggest the "motivational significance" of the reinforcers used with mentally retarded adults may differ greatly from those used with food deprived pigeons. The authors also suggest "interspecies behavioral differences" between pigeons and adult retarded humans may account for the lack of differential effect found in their subject group.

Despite the results reported by Dube et al, (1989), other researchers have replicated the DOE with human subjects and have shown that when compared with nondifferential procedures differential outcome procedures produce sizable improvements in discrimination accuracy. For example, Saunders and Sailor (1979) reported accuracy percentages 20% greater under DOE procedures in two of three subjects. Additionally, Jansen and Guess (1978) found accuracy percentages 40% greater under DOE procedures in two subjects and 30% greater under DOE procedures in another two subjects.

The vast majority of human DOE research has been conducted with children, especially mentally retarded children and learning disabled children. To date, no research has been done with adults recovering from head injuries, a population with special needs for efficient and effective discrimination training techniques.

As stated previously, individuals surviving a brain injury suffer impaired abilities to learn (e.g., Goldstein & Ruthven, 1983 and Rosenthal, 1983). One
example of a functional skill requiring learning of new discriminated responses is self-medication. Independent self-medication is a crucial goal for achieving independence if lifesaving medication regimens (e.g., seizure management) are required. The skill of discriminating between prescribed medications and/or between over-the-counter medications is prerequisite to self-medication. The following study evaluated the efficiency of the DOE when teaching medication discrimination to adult head injury survivors. In addition to attempting to replicate the DOE in head injured adults, using a clinically significant task, two other questions were examined.

1. Is the DOE restricted to stimulus objects used in training or does the DOE affect the ability to discriminate stimulus objects used in training from a range of alternatives to when they have no prior exposure?

2. Do differential and nondifferential procedures produce differing performance when actual pills are substituted for pictures of medications?
METHOD

Subjects

Three adult subjects were selected according to similarity of injury. The criteria for consideration of inclusion in the study restricted similarity to injury of the left frontal lobe. However, other areas of lesion were present for some subjects as noted below. In addition, each subject demonstrated a discrimination deficit in the screening procedure described in the procedures section.

Subject 1 was a 35-year-old male who sustained a head injury four years earlier and had received four years of rehabilitation. Records reported injury to the left frontal lobe and left parietal areas. He had a partial right side hemiplegia, very poor trunk stability and was consequently dependent on a wheelchair for mobility. The latest neuropsychology report revealed a full scale Wechsler Adult Intelligence Scale - Revised (WAIS-R) score of 71. Subject 1 was also on a regimen of 200 mg of Dilantin per day.

Subject 2 was a 31-year-old male who sustained a head injury nine years earlier and had received seven years of rehabilitation. Records reported injury to the left frontal lobe and left temporal lobe areas. He had severe dysarthria and had moderate ataxia in the lower extremities only. He was fully ambulatory. The
latest neuropsychology report revealed a WAIS-R full scale score of 75. Subject 2 was not on any regimen of prescribed or over-the-counter medications.

Subject 3 was a 21-year-old male who sustained a head injury eleven years earlier and had received eight years of rehabilitation. Records reported injury to the left frontal and right frontal lobe areas. Records also show an evacuation of an unknown amount from the right frontal lobe area. He demonstrates a right side hemiplegia in the lower extremity producing a limp. The latest neuropsychology report revealed a WAIS-R full scale score of 65. He has a seizure disorder requiring a regimen of 100 mg of Dilantin two times per day.

Materials and Setting

Medications were selected according to similarity in form and color. Training stimuli, screening stimuli and generalization probe stimuli were life-size color pictures of the medications extracted from a copy of the Physician's Desk Reference (1985) and mounted on 3x5 index cards. The cards were then covered with Scotch brand transparent tape to resist staining during the study. The same set of medication pairs were used for all subjects. Table 1 lists the pairs of medications used. Pairs were established by the primary trainer according to estimated visual similarity of form and color. Similarity was established to ensure sufficient difficulty in developing discriminations.
Table 1

Pairs of Brand Name Medications in the Order of Presentation to All Subjects

<table>
<thead>
<tr>
<th>Pair</th>
<th>Medication Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Depakote &amp; Erythromycin</td>
</tr>
<tr>
<td>2</td>
<td>Tofranil &amp; Dulcolax</td>
</tr>
<tr>
<td>3</td>
<td>Xanax &amp; Cogentin</td>
</tr>
<tr>
<td>4</td>
<td>Cytomel &amp; Lomotil</td>
</tr>
</tbody>
</table>

Reinforcers used for each subject were the following: Subject 1 received milk shakes and chocolate pudding. Subject 2 received Mounds Bars and Pepsi. Subject 3 received M&M's and root beer. Reinforcers were selected in two ways. Some reinforcers were chosen due to reinforcing effects noted in previous treatment procedures. Other items were chosen as reinforcers because the subject was observed in unstructured settings to consistently choose or request the items. All reinforcers, except the milk shake and pudding for Subject 1, were dispensed from plastic medication cups. The milk shake was dispensed through a straw and the pudding was dispensed with a spoon.

All sessions occurred in a 9-foot by 10-foot room. The room consisted of a round table 46 inches in diameter and two chairs placed approximately 2 feet from each other on the perimeter of the table.
Assessment Procedures

For all assessment procedures, correct responses were defined as placing a part of one hand on the requested medication within five seconds after the investigator stated the name of the required medication. Failure to make a response with five seconds of the instruction or a response to a medication picture other than the one requested was scored as an incorrect response. Any questions asked by subjects resulted in the experimenter stating he was unable to answer the question and the instruction repeated. Subject 1 and 2 began stating rules to themselves, some of which were accurate and some of which were inaccurate. Statements of rules at anytime during the study resulted in the investigator stating, “You may be right or you may be wrong. Only point to the medication I name.”

Discrimination training accuracy was recorded throughout training sessions which consisted of one session each day consecutively. At the beginning of each session, the subject was presented with the medication pair and the name of each was stated by the investigator while pointing to the respective medication. This occurred one time only at the beginning of each session. Each session consisted of 50 trials. Each trial consisted of presenting the medication pair in randomized position and stating the randomly selected medication of the pair to be pointed to by the subject. These presentations were then followed by one of the outcome procedures described under experimental conditions.
Generalization probes occurred for each medication pair immediately after the second discrimination training session and immediately after the last discrimination training session. Generalization probes to novel stimuli was assessed by presenting ten trials whereby the medication pair currently being trained was randomly interspersed among six novel pictures of medication. A trail consisted of laying out the eight pictures of medication and the investigator stating, “Point to the (medication name).” Each trail ended with the investigator collecting the pictures and holding them beneath the table out of sight. The trained medication pictures were randomly interspersed among novel pictures by shuffling the set of eight pictures and laying them in two columns of four beginning at the top left and continuing a right-left alteration until all pictures lay on the table. Each medication of the trained pair was designated as the S+ on five separate trials. All generalization probes occurred under extinction conditions where no feedback was given to the subject regarding correct or incorrect responses.

Probes using real medications occurred immediately prior to the first discrimination training session and immediately after the last generalization probe of discrimination probe respectively. Probes to real life medications occurred over ten trials whereby each medication of the pair was required on five separate trials. A trial consisted of the investigator holding one actual medication of the pair in each hand and stating the name of the required medication. Randomization of position and medication was achieved as in discrimination training sessions. All
probes to real medications occurred under extinction conditions where no feedback was given to the subject regarding correct or incorrect responses.

Dependent Measures

Two dependent measures were used in the study, percentage correct and number of trials to acquisition. Percentage correct consisted of dividing the number of correct responses within a session by the number of correct plus incorrect responses within the session. Percentage correct was calculated for discrimination training accuracy, generalization probes and probes using real medications. The number of trials to criterion consisted of the number of discrimination training trials presented until a criterion of 90% correct occurred within a session with no errors in the last 25 trials.

Experimental Design

The experimental design consisted of alternating differential and nondifferential outcome conditions in a counter balanced fashion across medication pairs. The order of medication pairs and conditions for each subject is presented in Table 2.
# Table 2

Order of Conditions for All Subjects and Corresponding Medication Pairs

<table>
<thead>
<tr>
<th></th>
<th>Pair 1</th>
<th>Pair 2</th>
<th>Pair 3</th>
<th>Pair 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 3</td>
<td>Non-Diff.</td>
<td>Diff</td>
<td>Non-Diff.</td>
<td>Diff</td>
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</tbody>
</table>
EXPERIMENTAL CONDITIONS

Screening

Potential subjects were first screened for a deficit in discriminating medications. Subjects were given 25 discrimination trials with a test pair of medications selected according to similarity of form and color. The medications differed from those used in subsequent discrimination training sessions and assessments. Each subject was presented with two medication pictures simultaneously and told, "This is Satric" while the experimenter pointed to Satric and each subject was told, "This is Meberal" while the experimenter point to Meberal. Each succeeding trail consisted of presenting both medication pictures simultaneously and asking the subject, "Please point to (Satric or Meberal)." Twelve trials required pointing to Satric and thirteen trials required pointing to Meberal and all trials occurred in random order and random position of presentation. No feedback was presented regarding performance. For inclusion, each subject had to score 60% or lower. Subjects 1, 2 and 3 scored 52%, 22% and 40% respectively.
Discrimination Training: General Procedures

All training sessions consisted of 50 trials of a two-choice discrimination task. Before the first trial of each session, the experimenter presented the medication pair in unpredictable locations, pointed to each item of the pair, and stated the name of the medication. The subsequent trials of each session consisted of presenting the medication pair and stating, "Point to the (medication name)." Randomization was achieved through use of two random numbers charts. Prior to each condition, even numbers were assigned to one medication of the pair and odd numbers assigned to the other medication of the pair. Additionally, the second randomized number chart was used by having odd numbers identify the left position and the even numbers identify the right position.

Incorrect responses or responses occurring more than five seconds after presentation resulted in no reinforcer and a correction procedure. The correction procedure consisted of the investigator pointing to each medication stating the medication name and then removing the pair until the next trial. Training continued at a rate of one session per day until acquisition was obtained. Acquisition was defined as at least 45 of 50 trials (90%) correct with no errors in the last 25 trials.
Differential Outcome Procedures

During differential outcome conditions, correct responding to each medication picture resulted in one of two reinforcers separately assigned to each medication of the pair. For example, Subject 1 received milk shake and only milk shake for correct responses to Tofranil and would receive chocolate pudding and only chocolate pudding for correct responses to Dulcolax.

Nondifferential Outcome Procedures

During the nondifferential outcome conditions, correct response to each item resulted in either of the two selected reinforcers. Assignment of the reinforcer for each correct trial occurred through the use of a random numbers chart to ensure random occurrence of each reinforcer. Odd numbers were assigned to one reinforcer and even numbers to the other reinforcer. Upon a correct response the next number of the chart was identified which subsequently dictated the reinforcer to be delivered. For example, upon correctly responding to Depakote, Subject 1 received chocolate pudding if an even number was next on the random number chart or would receive milk shake if an odd number was next on the random number chart. Likewise, upon correctly responding to Erythromycin, Subject 1 received chocolate pudding if an even number was next on the random number chart or would receive milk shake if an odd number was next on the random number chart.
Interobserver Agreement

Agreement measures were collected in 33% or more of all trials within each condition and are presented in Table 3. Agreement was defined as the experimenter and the agreement observer having the same score of “+” or “0” on the same trial. Combined exact interobserver agreement was calculated by dividing agreements by agreements plus disagreements and multiplying by 100. Agreement measures were also collected on the correct application of reinforcers in those same sessions. Agreement for correct application of reinforcers was defined as the agreement observer writing a “+” when the assigned reinforcer was presented upon correct responding to stated medication or no reinforcer upon incorrect responding. In those instances when the investigator made an error in presenting the assigned reinforcer or lack of a reinforcer, the agreement observer scores a “0” indicating a disagreement. Combined exact interobserver agreements were calculated by dividing the total agreements by the number of agreements plus disagreements and multiplying by 100. Interobserver agreement percentages for dependent variables ranged from 94% to 100% for Subject 1, from 98% to 100% for Subject 2, and 100% for Subject 3. Interobserver agreement percentages for independent variables ranged from 94% to 100% for Subject 1, from 92% to 100% for Subject 2, and from 96% to 100% for Subject 3.
Table 3
Agreement Scores Presented by Subject for Dependent Variables (DV) and Independent Variables (IV) in All Conditions

<table>
<thead>
<tr>
<th>Subject</th>
<th>DV</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>100% 100% 100%</td>
<td>94% 98% 100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DV</td>
<td>100% 100% 98%</td>
<td>94%, 97% 96%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>100% 92% 93%, 95%</td>
<td>100% 94%, 93%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Subject</td>
<td>100%, 98%, 100%</td>
<td>100% 98% 100%</td>
<td>100% 96% 100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100%, 98% 100%</td>
<td>100% 98% 100%</td>
<td></td>
<td>98%, 100% 100%</td>
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<tr>
<td>IV</td>
<td>96%, 100%, 98%</td>
<td>100% 100% 98%</td>
<td>98%, 100% 100%</td>
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<td></td>
</tr>
<tr>
<td>Subject</td>
<td>100% 100% 90%</td>
<td></td>
<td>94%, 97% 96%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>100% 90% 100%</td>
<td></td>
<td>94%, 97% 96%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>90%, 100% 100%</td>
<td></td>
<td>94%, 97% 96%</td>
<td></td>
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</table>

Interobserver Agreement Percentages
RESULTS

Session by session accuracy data for Subjects 1, 2 and 3 is graphed in Figures 1, 2 and 3. For all three subjects, the data consistently show more rapid acquisition of discrimination between medication pairs trained with the differential outcome procedure than those medication pairs trained with the nondifferential outcome procedure. Figures 4, 5, and 6 show the total number of trials to acquisition for Subjects 1, 2 and 3 across all conditions. For each subject, the total number of trials to acquisition was always smaller in the differential outcome conditions than in the nondifferential conditions.

Generalization Probes

Figures 7, 8 and 9 show the percentage correct during the final generalization probe of discrimination to novel pictures for Subjects 1, 2 and 3 across all conditions. All subjects responded above chance responding (12.5%). No consistent difference is seen across conditions within each subject or across subjects. However, only one subject on one trial responded to a novel picture. All other errors made by subjects in this assessment were made to one of the training pair. Subjects 1 and 2 showed an increasing trend across conditions, while Subject 3 showed a ceiling effect in all conditions.
Figure 1. Discrimination Training Accuracy for Subject 1 Across All Medication Pairs. Open Symbols Identify Pairs Trained Using Differential Outcome.
Figure 2. Discrimination Training Accuracy for Subject 2 Across All Medication Pairs. Open Symbols Identify Pairs Trained Using Differential Outcome.
Figure 3. Discrimination Training Accuracy for Subject 3 Across All Medication Pairs. Open Symbols Identify Pairs Trained Using Differential Outcome.
Figure 4. Number of Trials to Acquisition for Subject 1 On Medication Pairs 1 Through 4 Respectively.
Figure 5. Number of Trials to Acquisition for Subject 2 On Medication Pairs 1 Through 4 Respectively.
Figure 6. Number of Trials to Acquisition for Subject 3 On Medication Pairs 1 Through 4 Respectively.
Figures 10, 11 and 12 show pre-and post-test probes using real medications for Subjects 1, 2 and 3 across all conditions. Again, no consistent difference is noted across conditions for any subject. Interestingly, all subjects responded below chance on pre-test probes.
Figure 7. Data From Subject 1 for Generalization of Discrimination to Novel Pictures.
Figure 8. Data From Subject 2 for Generalization of Discrimination to Novel Pictures.
Figure 9. Data From Subject 3 for Generalization of Discrimination to Novel Pictures.
Figure 10. Percentage Correct for Subject 1 Pre-test and Post-test Probes Across All Medication Pairs 1 Through 4 Respectively Using Actual Medications.
Figure 11. Percentage Correct for Subject 2 Pre-test and Post-test Probes Across Medication Pairs 1 Through 4 Respectively Using Actual Medications.
Figure 12. Percentage Correct for Subject 3 Pre-test and Post-test Probes Across Medication Pairs 1 Through 4 Respectively Using Actual Medications.
DISCUSSION

In attempt to replicate the DOE in teaching medication discriminations, the efficiency of differential outcome and nondifferential outcome procedures was compared. Additionally, the effects of the differential outcome procedures and nondifferential outcome procedures upon generalization probes to novel medications was investigated. Finally, the effects of differential and nondifferential outcome procedures on probes to real medications was investigated. The results showed the differential outcome procedure employed produced the desired discrimination more rapidly than the nondifferential outcome procedure. No conclusive statement can be made regarding data obtained in generalization probes or in probes with real medications.

These data replicate the DOE with three brain injured adult males thus extending the generality of the DOE beyond nonhumans, learning disabled and autistic children. Because dependent measures used by other authors (e.g., Jansen & Guess, 1978; Hewett, 1965; Saunders & Sailor, 1979) centered on end result accuracy percentage, comparison to these studies regarding effectiveness is limited. With regard to number of trials to acquisition, the data obtained here are consistent with those obtained by Litt and Schreibman (1981).

The study clearly demonstrated differential outcome procedures as well as nondifferential outcome procedures may be used to teach medication
discriminations to some head injured adults. It also shows by using differential outcome procedures, rather than nondifferential outcome procedures, more rapid acquisition may be obtained. It is encouraging that head injured adults with left frontal lobe and/or left temporal lobe injuries may be sensitive to the DOE and may benefit through the application of the DOE within their rehabilitation.

At first blush, the difference in the number of trials to acquisition for the two procedures may appear small. However, if the number is considered across a multitude of discriminations necessary to be trained for a head injured individual, the difference grows. Consider that the hourly rates for occupational and speed therapies vary between $70 and $130. Including set-up time, each 50 trial session in this study required one hour of time. The data presented here suggests a potential savings of 50-200 trials or 1-4 hours of therapy per discrimination. Using the highest hourly therapy rate, a savings of $130-$520 per discrimination is suggested. Conservatively estimating 10 discriminations for a client indicates a savings of 500-2,000 trials or $1,300-$5,200.

Even though differential outcome procedures reliably produced acquisition more quickly than nondifferential outcome procedures with all three subjects, post-test measures to real medications showed no difference in the accuracy levels produced by each procedure. The data from these three subjects suggest no difference in the ability of each procedure to ultimately produce the discrimination. The lack of a difference between these two procedures in ultimately producing the discrimination should not be surprising. Two choice discrimination procedures
have been used for years to produce discriminations in a variety of subject populations and it should not be surprising that it would produce discriminations in head injured adults. Moreover, the training stimuli used were life-size photographs of the medications extracted from the Physician's Desk Reference thus producing a high degree of similarity across many stimulus dimensions regardless of the discrimination procedure employed.

A subsequent question asks why use the differential outcome procedure if the same accuracy can be produced with nondifferential procedures? Simply stated, the employed differential outcome procedure produced the discrimination more rapidly. With current national concern over the cost of health care, the above cited savings may justify the use of differential procedures when possible.

Data collected on generalization of the discrimination to novel pictures interestingly showed increasing trends across conditions for two or three subjects making interpretation difficult. However, Subject 1 made only one error to the novel pictures of medication and Subjects 2 and 3 made no errors to novel pictures of medication. Thus, all errors were made to one of the trained pairs. Interestingly, during generalization probes accuracy was disrupted for Subject 1 and Subject 2 even though they had met a 90% training criterion not more than 10 minutes prior to the probe. This may be result of the presence of the other 6 novel medications changing the ambient or setting stimuli in which the discrimination was initially produced.
The limitations of this study are apparent. Only three subjects were used in this study, thus limiting the generality of the findings to other head injured individuals. Additionally, this study enlisted the participation of subjects who were multiple years post-injury and who had received many years of rehabilitation. Consequently, the results may not be extended to persons with more recent brain trauma. Finally, the present study focused on medication discrimination and not the entire chain of behavior necessary for self-medication. The results are important for teaching prerequisite discriminations but does not guarantee reliable and accurate occurrence of the entire chain of behavior necessary for self-medication to occur.

Future studies on the DOE and head injured adults should assess the presence of the DOE in persons not only more recently injured, but with persons of varying locations of insult to the brain. Additionally, designs using ABBB, AABB and AAAB orders of conditions across subjects with consistent pairs of stimuli may limit interference from cumulative effects such as those shown in this study's data on generalization probes to novel pictures of medication. The current study also required only a selection based response (pointing) to come under the conditional control of the stated medication and the presented picture. An interesting question asks if the DOE is more or less prominent with form based responding (speaking) under the single control of the card?

In summary, these data replicate the DOE and extend the generality of the phenomena beyond nonhumans and learning disabled humans. Though it appears
that either differential or nondifferential outcome procedures may be used to produce medication discriminations in head injured adults, it is apparent the more rapid acquisition may be expected with differential outcome procedures.
Appendix A

Human Subjects Institutional Review Board Clearance
Date: May 28, 1991
To: Scott Votava
From: Mary Anne Bunda, Chair
Re: HSIRB Project Number 91-04-11

This letter will serve as confirmation that your research protocol, "Teaching Head Injured Adults to Discriminate Medications using the Differential Outcome Procedure," has been approved after full review by the HSIRB. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any change in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

xc: Wayne Fuqua, Psychology

Approval Termination: May 28, 1992


