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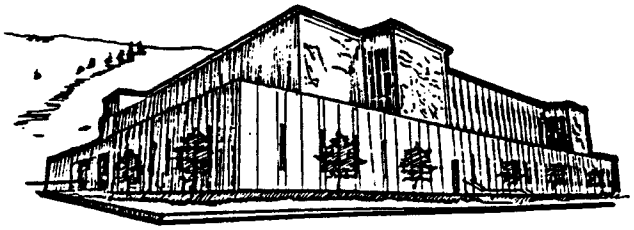

NORMATIVE STUDY OF THE *PORTLAND DIGIT RECOGNITION TEST:* AN ASSESSMENT OF THE EFFECTS OF MOTIVATION ON NEUROPSYCHOLOGICAL EVALUATIONS

By

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ABSTRACT

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This study provided normative data for the *Portland Digit Recognition Test* (*PDRT*), a forced-choice recognition memory test designed to aid in the detection of malingering in patients undergoing neuropsychological evaluations. The effects of age, gender and neuromedical risk on *PDRT* performance were examined. The extent to which performance varied as a function of the length of the interpolated delay interval also was evaluated. Likert-type items assessing motivation and estimation of enhanced performance for compensation were administered following the *PDRT*. Significant decrements in performance with longer delay intervals were hypothesized. It was predicted that the results would be negatively skewed, with all subjects obtaining scores appreciably above the chance level.

The normative sample consisted of 120 college students and local volunteers who passed a preliminary neuromedical screening. Results were negatively skewed with all subjects scoring appreciably above the chance level. Males scored significantly higher than females on Trial Block 1 (5 sec. delay). Medical risk factors associated with educational difficulties and the Total Risk score were found to covary significantly with Trial Block 1 scores. There was a significant decrement in performance between the 5 sec. and 15 sec. trial blocks, as hypothesized; however, there was a significant increment in performance between the 15 sec. and 30 sec. trial blocks. A significant increment in performance also was observed between the first and second 30 sec. trial blocks. Differential endorsements on the Motivation item were associated with significant variation in *PDRT* scores.

An excluded sample of 89 subjects who did not pass the preliminary screening were given the same assessments as the normative sample. Results for the excluded sample were similar to those for the normative sample, with the exception of there being no main effects for sex and significant main effects for the Compensation item. Scores for the excluded sample were not significantly different from those for the normative sample. Implications of the present study are discussed in light of previous research by Binder and Willis (1991).

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Introduction

Important decisions with the potential to change the courses of individuals' lives are routinely made on the basis of psychological assessment data. Young children are determined to possess intellectual handicaps such as learning disabilities or mental retardation, potential employees are screened for their efficacy in a given occupational role and criminals are assessed for their competency to stand trial. Because of the critical nature of the decisions which rest on these assessments, the psychometric soundness of the measurement instruments utilized is crucial, thus well researched. However, even a well constructed assessment device may be vulnerable to produce erroneous data if the individual who is being assessed responds in a way which is inconsistent with his or her actual behavior or ability level. The motivations of the subjects of psychological evaluations are undoubtedly as complex and diverse as the goals of the assessments. While many situations are structured such that an individual has intrinsic and/or extrinsic motivation to respond sincerely or to perform at an optimal level, there are other instances in which one could be motivated to respond deceptively. Motives may vary widely in their origin and intensity, from avoiding prosecution by feigning incompetence, securing compensation by exaggerating or simulating an injury, to meeting dependency needs by pretending to be mentally ill.

Deception, which is also referred to as malingering or dissimulation in the literature is defined in the DSM-III-R (American Psychiatric Association, 1987) as the "intentional production of false or grossly exaggerated symptoms, motivated by external incentives..." (p. 360). Resnick (1988) reports that estimates of the incidence of malingered psychological symptoms after an injury range from one 1% to over 50%.

While malingering traditionally has been viewed as a dichotomous variable, Rogers (1988) suggests that it should be viewed in terms of gradations existing along a continuum. A related issue, concerning the degree to which dissimulation is under conscious control, cannot be addressed clinically due to the absence of "behavioral or clinical concomitants from which to assess conscious intention" (Cunnien, 1988). The inability to ascertain individuals' level of conscious motivation seriously compromises clinicians' ability to discriminate between intentional malingering and conversion disorders, in which, following an injury, individuals exhibit persistent pain and loss of function which is unexplainable in terms of organic pathology. Even in relatively more clear-cut cases of malingering, clinicians are hesitant to make a diagnosis of malingering due to the ethical and legal ramifications of "false positive" errors.

Clinicians vs. Lawyers: Fortifying vs. Discrediting the Validity of Psychological Assessment Data

Due to the current lack of objective indices of malingering, a heated controversy has arisen in the dissimulation literature between researchers representative of two major factions of professionals, clinical psychologists and lawyers. Researchers supporting the efficacy of psychological assessment techniques and testimony are attempting to establish valid and reliable indicators for the detection of malingering (e.g., Rawling & Brooks, 1990). Lawyers, who in the course of defending or prosecuting litigants often are highly motivated to discredit the testimony of clinical neuropsychologists, are attempting to establish empirically that clinicians cannot distinguish between malingerers and nonmalingerers at a rate much better than chance (e.g., Faust, 1988; Ziskin, 1988). The confirmational biases associated with these opposing hypotheses makes the current literature in this area difficult to evaluate and interpret.

The paradigm employed by David Faust, the most prolific researcher in the lawyer faction, involves having clinicians blindly (i.e., without having conducted the assessment) evaluate protocols, some or all of which are bogus, to determine whether a diagnosis of neuropsychological impairment is appropriate. In a controversial study (Faust, Hart & Guilmette, 1988) children were instructed to "fake

bad" on a comprehensive neuropsychological assessment with minimal coaching as to how to proceed. Because 93% of the clinicians who reviewed the cases diagnosed abnormality, the researchers concluded that individuals *can* fake believable deficits on neuropsychological assessments. In a two-part follow-up, Faust, Hart, Guilmette & Arkes (1988) purportedly fortified this claim by instructing three teenagers to "fake bad" on neuropsychological testing. In the first study, the test results and a fabricated history of mild to moderate head injury were sent to a representative sample of clinical neuropsychologists, 75% of whom judged the test results to be abnormal and attributed the results to cortical dysfunction. None detected malingering. In the second study, the effects of forewarning on the case appraisal were examined by sending equal numbers of actual and feigned results to a new sample of neuropsychologists who were informed of a 50% base rate for malingering. Despite confidence in their evaluations, clinicians did not surpass the level of chance in their detection of malingering. Faust et al. again concluded that convincing deficits *can* be faked on neuropsychological assessments and further that "clinicians' overconfidence in their ability to detect simulation may partly explain why so little research has been devoted to this topic (p. 508)."

In a response to these claims, Bigler (1990) attacked the external validity of the Faust et al. research on the

basis of a number of methodological issues, including the limitations of the questionnaire format utilized in the study, the inexperience of the neuropsychological judges employed and the questionable nature of the process used to select them.

Faust and Guilmette's (1990) response to Bigler's criticism is well summarized by their article's title "To Say It's Not So Doesn't Prove That It Isn't: Research on the Detection of Malingering. Reply to Bigler." A fervent response to Faust and Guilmette's assertion by the clinical neuropsychological community in the form of research is currently underway (P. Bach, personal communication, August 1991).

The "simulation malingering paradox" has been used to identify measures which discriminate the response patterns of faking subjects from normal controls and/or patients with brain damage. These studies involve administering a number of standardized tests and tests specifically designed to detect malingering, after which multivariate statistics generally are applied to identify discriminant functions which reliably discriminate between groups. In addition, test profiles are scrutinized for internal inconsistency of deficit patterns (Benton, 1961; Boone & Filskov, 1990; Goebel, 1983; Heaton, Smith, Lehman & Vogt, 1978; Kerr, Gramling, Arora, Beck, Morin, Cole & Irby, 1990; Pankrantz, 1988; Rawling and Brooks, 1990; Suffield, Davidson, Nantau,

Orenczuk & Mandel, 1990). While group differences between subjects feigning malingering and nonmalingerers repeatedly have been established utilizing this paradigm, the clinical utility of such procedures for identifying malingering in individual patients is limited due to the absence of cross-validation data on specific indices and cut-off scores (Boone & Filskov, 1990). In addition, even if measures could be devised and cross-validated on the basis of inter- and intrasubtest inconsistency within an extensive battery of assessments, the components of which may not be relevant to a particular patient, there may be legal, ethical and practical constraints to employing such laborious methods in the detection of malingering.

There would be obvious advantages to a simply administered screening device which could signal the possible existence of malingering at the outset of a neuropsychological evaluation, so that subsequent behavioral observations and techniques could be employed to substantiate or dispute its existence. Several such techniques have been devised and tested (Pankratz, 1988). Most of these techniques are designed such that they appear more difficult than they actually are, thus the malingering subject routinely performs considerably below expected levels, unwittingly revealing his dissimulation. Possibly the most effective techniques identified to date for the detection of malingering are forced-choice techniques in

which the subject has a 50/50 chance of responding correctly to each item; thus, over a number of trials, response rates significantly below the level of chance suggest the deliberate production of wrong answers (Binder & Willis, 1991; Pankratz, 1983). Often, individuals instructed to "fake bad," subjectively experience the 50% hit rate as "too successful" and consequently produce scores which are appreciably below chance (Binder & Pankratz, 1987). Hiscock and Hiscock (1989) recently refined one such technique, the *Portland Digit Recognition Test* - a forced choice digit recognition task. The task as described by Binder and Willis (1991) involves the auditory presentation of 5-digit strings, followed by a 5 or 15 sec. delay ("Easy items"), or a 30 sec. delay ("Hard items"), during which the subject performs a distractor task (counting backward from 20, 50 or 100), after which a visual probe card with the target item and a distractor is presented. Prior to the presentation of the "Hard items" subjects are told that the task will become more difficult due to the lengthening of interpolated delay interval. Binder and Willis (1991) subsequently demonstrated that it was possible to differentiate subjects with different motivational levels on the basis of their performance on this simply administered test of recent memory. Patients receiving financial compensation as a result of minor head trauma performed significantly more poorly on the *Portland Digit Recognition Test* than patients

with well-documented brain dysfunction or affective disorders who were not applying for compensation. These findings are compelling in that this is the first research to demonstrate significant group differences in an actual patient population utilizing one simply administered assessment device.

Rationale and Design

It seems that the next step in facilitating the use of the *Portland Digit Recognition Test* in clinical settings would be to establish a baseline against which an individual patient's performance may be compared. Consequently, the purpose of the present study was to establish the normal performance of subjects not at risk for neurological impairment on the *Portland Digit Recognition Test*, so that deviations from this expected pattern could be delineated more effectively in clinical settings. While a non-patient group was included in the Binder and Willis (1991) study, the sample size was extremely small (n=13). The present study utilized a much larger sample size (n=120) to increase the probability that significant normal trends would be uncovered and to decrease the probability that results would be affected unduly by chance fluctuation. Also, Binder and Willis (1991) reported significant age differences across subject groups which was not controlled because no significant relationship between age and performance was found. It could be argued that the diversity of the

subjects included in the Binder and Willis (1991) sample could be responsible for the absence of age-related differences in performance. The more homogeneous sample utilized in the present study was stratified for age to increase the likelihood of uncovering age differences, should they exist. Similarly, while Binder and Willis (1991) found that males and females in their sample had almost identical means, the present sample was stratified according to gender, so that the effect of this variable in a larger, less heterogeneous sample could be assessed. Also, the present study included additional parameters for analysis. Medical risk indices were quantified (See "Method" section) and included in the data analysis. In addition, decay curves for the various time delays were graphed for comparison across the subject groups.

In addition to enhancing the usefulness of this instrument in clinical settings, the present study was intended to contribute to laying the groundwork for future investigation aimed at elucidating the dynamics of this definitionally maligned phenomenon - malingering. It sometimes seems that after a behavioral phenomenon which is perceived as negative is labeled as such and targeted for identification solely for the purpose of eradication, the perspective through which it is viewed is narrowed to the extent that complex dynamics may be obscured if not ignored. It is hoped that by providing a gauge against which the

performance of individuals suspected of malingering can be compared, systematic discrepancies may be uncovered and further research into the intricacies of this ill-understood phenomenon may be designed and implemented.

The global construct of malingering considered in the context of a psychological evaluation has significant potential theoretical importance. As greater definitional clarity regarding the underlying dynamics of this phenomenon is achieved, subtypes of the behavior and factors in the environment and individuals which predispose its occurrence may be identified, providing the dual benefit of aiding clinicians in assessing and treating their clients and enhancing scientific understanding of the complexities of human motivation.

Relevant Memory Research

Hintzman (1990) described two major trends which have been evident in recent memory research, efforts toward the development of formal theoretical models (labeled "connectionist"), and an experimental paradigm involving the comparison of different memory tasks (labeled "dissociationist"). Connectionist or "neural network" theories have received considerable attention recently to the extent that they have been declared a "paradigm shift" for psychology. Hintzman describes the "dissociation" method of experimentation as "enormously influential." It is viewed as an outgrowth of the "proliferation of tasks"

designed to measure memory, which resulted inevitably in the comparison of different tasks as a means of clarifying the mechanisms involved in different forms of memory and memory involving various stimuli. While a discussion of the subtleties of connectionism and dissociationism is beyond the scope of the present paper, the interested reader is referred to Hintzman (1990) for a thorough review.

There are several dual-process theories of recognition which have persisted for some time (e.g., Atkinson & Juola, 1973; Jacoby & Dallas, 1981; Johnston et al., 1985; Mandler, 1980). Mandler (1980) reviewed the evidence for these theoretical positions and substantial support for the models was provided. The basic premise of these models is that a "rapid, direct access familiarity response (based on trace strength, perceptual integration, or perceptual fluency, depending on the model) is separate from a slower recall or search process based on associative or elaborative processing." (Johnson & Hasher, 1987; p. 643). Gillund & Shiffrin (1984) have proposed that these models may have over-emphasized the search factor. They suggest that the familiarity responses underlying recognition are affected both by the associations between items and between items and context, essentially that the activation level of the item is determined by the simultaneous activation of episodic traces, which is conceptually similar to Hintzman's (1986) position that recognition relies on "echo intensity"

(Johnson & Hasher, 1987).

Issues of importance in recognition research have included investigating: age differences in recognition performance; gender differences; practice effects; modality match between stimulus and probe conditions; similarity between old and new test items (probes and distractors); and repetition effects. Pertinent results will be reviewed briefly for the purpose of buttressing the hypotheses which follow and providing the rationale for implementing some of the control measures described in the methods section.

While progressive decrements in overall memory with advancing age tend to be the general rule, closer examination of age effects on different types of memory tasks reveals that the pattern is considerably more complex. Bowles and Poon (1982) examined age differences in recognition memory utilizing a standard two-alternative forced-choice paradigm and found no significant difference in accuracy between the younger adults (mean age = 22) and older adults (mean age = 72); however, the distribution of scores for the older group differed in that it was bimodal with the upper mode not differing from that of the younger group, but the lower mode representing a significant decrement in performance. Utilizing the *Rey Auditory Verbal Learning Test,* Bleecker, Bolla-Wilson, Agnew and Myers (1988) found that while age and sex accounted for a significant portion of the variance on a recall task, the

recognition trial was not affected by age or sex. Craik and McDowd (1987) found greater age losses in recall than recognition, suggesting that it fits with the general scheme that older people perform less well on any difficult task; however, the researchers preferred to substitute the concept of "difficulty," which may be subject to various interpretations with that of tasks requiring "more self-initiated activity or more processing resources." Results from Light and Anderson (1985) appear to support this hypothesis in that age-related decline in recognition of prose (which could be seen as involving higher level processing) was found. Scrutiny of age-related performance on tasks presumably requiring relatively less complex processing on the *Wechsler Memory Scale - Revised* (e.g., Digit Span; Figural Memory) reveals consistent, slight decrements across age groups of apparently non-significant proportions (i.e., when contiguous groups are compared). Unfortunately, no study examining age differences in a forced-choice memory task employing a Brown-Peterson paradigm could be found other than Binder and Willis (1991) which found no correlation between age and level of performance. The diversity inherent in the subjects utilized in this study makes it unclear whether this is a reliable finding. It is possible that performance of a distractor task during the delay interval could increase the processing complexity of the *PDRT* to the extent that age

differences may become evident given a sufficiently large sample size with relatively uniform characteristics.

With the exception of certain instances of facial recognition (e.g., McKelvie, 1984) gender differences in recognition memory repeatedly have been found to be negligible.

Postman (1982) found no evidence of practice effects with feedback and experience on either a yes-no or forced-choice recognition test, which the author attributed to "the difficulty of identifying and implementing test-appropriate strategies" (p. 333). Elliott, Geiselman & Thomas (1981) used a four-alternative recognition test within a modified Brown-Peterson paradigm and found that performance decreased more quickly with increased length of the distraction interval when the test modality (auditory or visual) did not match the modality of presentation than when the modalities did match. Other evidence suggests that there is better recall for recency items presented in the auditory modality than for items presented in the visual modality (Horton & Mills, 1984).

Tulving (1981) describes a robust rule regarding similarity in recognition memory, that is, "recognition accuracy is inversely related to the similarity between the old and new test items" (p. 479) with the exception of a relatively more complex situation involving memory for photographs. Similarity between old and new items has been

referred to as "a very powerful variable" (Kintsch, 1970) and as "the most important of stimulus variables affecting perception and recognition alike" (Podgorny & Shepard, 1978).

Repetition effects have been found to be significant in enhancing performance on memory tasks. Recognition has been found to be increased monotonically as a function of the number of item presentations (Richardson-Klavehn & Bjork, 1988).

Research Objectives and Hypotheses

While the primary purpose of the present study was to provide normative data for the *Portland Digit Recognition Test*, another purpose was to investigate whether there were significant differences in performance on the test between subject groups as a function of age, sex and medical risk status.

Several hypotheses were put forth on the basis of the research just reviewed. It was predicted that all subjects would perform at or above the chance level, with the preponderance of subjects performing at a level considerably above the chance level and no subjects performing significantly below chance. Similarly, it was predicted that the frequency distribution of subjects' recognition scores would be negatively skewed. It was expected that performance levels in the present study would be slightly below that of normal subjects in Binder and Willis' (1991)

study due to the fact that a lower mean level of education was likely in the present sample.

It was predicted that there would be significant differences between overall subject performances on Easy vs. Hard items, with a significant decrement in overall performance exhibited between the short (5 and 15 sec.) vs. longer (30 sec.) distractor interval due to the interpolated task interfering with rehearsal (Brown, 1958; Peterson and Peterson, 1959).

Method

Subjects

An age and sex stratified sample of 120 subjects passing the preliminary neuromedical screening (described below) was obtained, including 30 subjects (15 male, 15 female) in each of the following age groups: 18-20; 21-25; 26-30; 31-45. The total number of subjects tested in the process of obtaining the 120 screened subjects was 243. Subjects who unambiguously did not pass the screening constituted the "excluded" sample (n=89). Please consult Table 1 for a breakdown of excluded subjects by age and sex. The remaining 34 subjects were not included in either the normative or excluded sample: 20 subjects provided insufficient information on the screening for a determination of whether or not they passed the screening to be made; 8 subjects were eliminated due to missing data; and 6 subjects were eliminated because they passed a lightened

version of the screening (described later in this section), but were not needed for the normative sample as the subject quotas in the various cells had been fulfilled.

During the initial stages of data collection, subjects were exclusively Introductory Psychology students at the University of Montana who participated to obtain experimental credit which is required for their successful completion of the course. Later in the data collection period, alternate methods of subject recruitment were employed due to a large number of subjects not passing the neuromedical screening and due to there being insufficient numbers of older students enrolled in the Introductory Psychology course. A number of subjects were recruited through other University courses. Some of these subjects participated on a voluntary basis, while others were offered extra credit by their professors. Subjects were also recruited through sign-up sheets posted at various locations on the campus. These subjects were paid $5.00 for their participation. Finally, several subjects were recruited on a voluntary basis from the local smokejumper base.

Subjects were screened for neuromedical risk factors utilizing a two-part screening questionnaire developed by A. Tindall (1990). The *Preliminary Screening* (See Appendix A) included questions regarding the subjects' neurological, psychiatric and drug history. Subjects were excluded from the normative sample on the basis of Tindall's (1990)

criteria (See Appendix A); however, data from unambiguously excluded subjects were subjected to post-hoc analysis with the hope that significant trends in the data in accordance with neurological status might be uncovered. Due to difficulty obtaining subjects in sufficient numbers later in the data collection period, the exclusion criteria were lightened to include subjects in the normative sample who reported having had a neuropsychological test, but had not been evaluated by a neurologist or a neurosurgeon and had not been diagnosed with a neurological condition.

The second portion of the neuromedical screening, the *Medical Risk Screening* (See Appendix B) included questions regarding risk factors in the following seven categories: early development, education, mild head injury, toxicity, anoxia, illness risk, and family history. Rather than excluding subjects from the normative sample on the basis of a certain threshold level of medical risk factors, Tindall's (1990) procedure for quantifying the indices and including them as a variable for analysis was employed.

Procedure

Upon arrival at the testing site, the subject was invited into the assessment room during which time the examiner attempted to establish rapport. Subjects were told that they were free to withdraw from participation at any time and were informed of the measures that would be taken to safeguard the confidentiality of the information they

provided. Subjects initially completed the neuromedical screening questionnaires described previously. Subjects were administered the *Portland Digit Recognition Test* by one of several trained examiners. Prior to this time the examiners became proficient in the administration and scoring of the *PDRT* to maximize standardization and control. After the subject and examiner were seated at opposite sides of the assessment table, the task was introduced as a test of memory. The examiner encouraged the subject to do his or her best and then introduced and implemented the assessment in accordance with standardized instructions (See Appendix C). The examiner recorded subject responses on a *PDRT* test protocol (See Appendix D).

Due to the research described previously relating to repetition effects, it was emphasized in training the examiners that subject attention should be gained prior to presenting items, because repetition of items was not allowed under any circumstance as it would render the results invalid. Following administration of the *PDRT*, subjects were given two Likert-type items (See Appendix E). The first item was intended to provide the subject's retrospective estimation of their level of motivation while taking the test. The second item asked subjects to estimate the extent to which they felt they could have performed better if they had received financial compensation to do so. At the conclusion of the assessment period, subjects were

given an opportunity to ask any remaining questions they might have and they were told how they could learn the results following completion of the project. Credit sheets for participation were completed for subjects immediately following the assessment period. Subject names did *not* appear on the assessment data; rather, all data pertaining to a given subject were assigned a code number in order to safeguard confidentiality.

Independent Measures

Sex, age group membership, Motivation item endorsement, Compensation item endorsement, and the eight medical risk scores described previously were the independent variables used in this study. In addition, for the purpose of comparative analyses between the normative and excluded group, status with regard to the neuromedical screening constituted an independent measure. Those passing the screening were considered "normative" subjects while those who unambiguously did not pass were the "excluded" subjects.

Dependent Measures

Dependent measures obtained from the *PDRT* included the total raw score (number correct) and the raw score for each of the four 18-item trial blocks. Trial Block 1 was comprised of the 5 sec. delay items; Trial Block 2 was comprised of the 15 sec. delay items, Trial Blocks 3 and 4 were the 30 sec. delay items. The subscores were also computed at two levels, rendering two additional dependent

measures which are comparable to the subscores utilized in Binder and Willis' (1991) research. The 18 five sec. and 18 fifteen sec. delay trial blocks were combined to constitute 36 "Easy" items; and the two 18-item, 30 sec. trial blocks constituted the 36 "Hard" items.

Results

Normative Sample

Means, standard deviations and ranges for the dependent variables for the normative group and the excluded group are presented in Tables 2 and 3. Table 2 lists descriptive statistics for *PDRT* subscores for Trial Blocks 1 through 4. Descriptive statistics for total scores and for "Easy" and "Hard" subscores which correspond to Binder & Willis' (1991) research are presented in Table 3. Means itemized by age, gender and age x gender are presented in Tables 4 through 6, respectively. Statistics for Binder and Willis' (1991) normative group are included in Table 3 to facilitate comparisons with the present study. Means for Easy, Hard and total scores for the current normative sample were consistent with those obtained for Binder & Willis' small nonpatient control group (n=13) with discrepancies of less than one half point.

An initial analysis of variance (ANOVA) was performed to determine whether there were significant differences between subjects who were admitted to the normative sample utilizing less stringent screening procedures (adopted later

in the data collection period) and those who were admitted with the regular criteria. These results were nonsignificant.

A test for homogeneity of the regressions was conducted to determine whether there were significant interactions between either or both of the between subjects factors (i.e., age and/or gender) and the medical risk scores. None of these analyses produced significant results (See Table 7 for a summary of results), suggesting that the covariates could be entered in subsequent analyses without introducing interpretation problems.

A covariate analysis of variance (CANOVA) was conducted to determine whether there were significant differences in *PDRT* total scores as a function of sex and/or age group membership without the influence of effects due to medical risk status (See Table 8 for summary of F-ratios). There were no significant interactions or main effects as a function of sex and/or age group membership. None of the covariates were significantly related to *PDRT* total scores.

Two additional CANOVA's were conducted utilizing each of the subgrouping schemes for the *PDRT* scores (See Tables 8 and 9 for a summary of F-ratios). An analysis of Easy and Hard scores as a function of sex and age group membership with medical risk scores entered as covariates yielded main effects for sex which were marginally significant on the Easy items $\underline{F}(1,119)= 3.88$, $\underline{p}=.051$ with males producing

higher scores than females (See Table 5 for means). With regard to the covariates, the "education" medical risk score which is comprised of questions related to educational difficulties (i.e., learning problems, special education services, etc.) was significantly related to the score for Easy items, $F(1,119)=4.69$, $p<.05$. The "early history" medical risk score which is comprised of questions related to prenatal, perinatal and early childhood medical problems was also related to the score for Easy items at a level approaching significance, $F(1,119)=3.83$, $p=.053$. No significant sex, age or sex x age effects or covariate effects were obtained for the Hard items. A second CANOVA was utilized to examine scores for Trial Blocks 1 through 4 as a function of sex and age group membership. Significant main effects for sex were obtained for Trial Block 1, $F(1,119)=9.35$, $p<.01$, again with the mean score for males being higher than that for females. The "education" medical risk score was significantly related to scores on Trial Block 1, $F(1,119)=8.59$, $p<.01$. There were no significant covariate effects, main effects or interactions for scores on Trial Blocks 2 through 4.

Analyses were conducted to investigate whether the total medical risk score (i.e., the composite score of all medical risk indices) was related to the *PDRT* total score or any of the subscores. Only one of these analyses produced significant results. The total risk score accounted for a

significant amount of the variance for Trial Block 1, $F(1,119)=4.31$, $p<.05$.

Several analyses were conducted to determine the nature of effects associated with the increasing length of the interpolated delay interval (See Table 10 for a summary of results). An initial examination of means revealed a potential contradiction between the present findings and those from Binder & Willis' (1991) small norm sample. While in Binder and Willis' study, there is a slight decrement in performance between the Easy vs. Hard items, the opposite trend is observed in the present study (See Figure 1 for a graph of this trend). However, a within-subjects multivariate analysis of variance (MANOVA) revealed that the observed increment in performance between the Easy vs. Hard items was not significant. A more fine-grained analysis was conducted utilizing another MANOVA examining the within subjects factor of delay at three levels, across Trial Blocks 1 through 3. A significant effect for difficulty was obtained, $F(2,238)=40.84$, $p<.001$. This effect was examined more closely utilizing an examination of the means for the three trial blocks and successive MANOVA's to make comparisons between each trial block and the following trial block. This revealed a significant decrement in performance between Trial Block 1 and Trial Block 2 consistent with the hypothesis that poorer performance will result with an increased interpolated delay period, $F(1,119)=49.90$, $p<.001$.

However, a significant *increment* in performance was observed between Trial Block 2 and Trial Block 3, which contradicts the aforementioned hypothesis, $F(1,119)=5.60$, $p<.05$. An additional MANOVA revealed that there was a significant increment in performance between Trial Blocks 3 and 4 as well, $F(1,119)=10.44$, $p<.01$. See Figure 2 for a graph of mean scores as a function of delay across Trial Blocks 1 through 4.

Several analyses were employed to assess whether the Motivation and Compensation items administered following the *PDRT* were significantly related to the *PDRT* total score. The first item, which was intended to provide a self-reported retrospective estimation of motivation, asked subjects to rate on a scale from 1 (strongly disagree) to 5 (strongly agree) the extent to which they felt they had performed to the best of their ability on the task. A MANOVA with special contrasts between adjacent means was utilized to determine if there were significant differences in total *PDRT* scores in accordance with this measure of self-reported motivation and, if so, what the direction and extent of these differences were. There were significant differences in total *PDRT* scores as a function of motivation, $F(4,115)=4.14$, $p<.01$. A closer examination of the effects utilizing the special contrasts between adjacent means revealed an interesting pattern of results. Because there was only one subject who responded "2," legitimate

statistical comparisons could not be made with this endorsement level. However, examination of the means for endorsements of "1" and "2" revealed that these subjects scored higher than individuals endorsing "3," which is contrary to the pattern that would be expected on an intuitive basis (i.e., increasing levels of performance with increasing levels of self-reported motivation). A t-test confirmed that the mean score for individuals endorsing "1" was significantly higher than that for individuals endorsing "3" (t=2.39, df=8, p<.05). Comparison of means for motivational levels 3, 4 and 5, revealed results which were consistent with what might be expected. Individuals responding "3" performed significantly more poorly than those responding "4" (t=-2.62, df=4, p<.01) and individuals responding "4" performed more poorly than individuals responding "5" at a level approaching significance (t=-1.96, df=4, p=.05). Scrutiny of the means across motivational categories revealed that the means for individuals responding "3" appeared consistently and significantly lower than means for all of the other motivational levels. Another MANOVA specifying contrasts between each motivational level and the mean across levels revealed that individuals responding "3" did in fact score significantly lower than the mean across levels, while this was not the case for any of the other motivational levels (t=-3.37, df=4, p<.001).

The Compensation item was intended to assess the extent to which subjects felt they would have performed better if they had received financial compensation to do so. The numbering convention was the same as for the previous item, with an endorsement of "1" meaning "strongly disagree" and "5" meaning "strongly agree." An ANOVA was conducted to determine the extent to which differential endorsements were related to differences in *PDRT* total scores. The results were not significant. See Table 11 for sample means associated with the various endorsements for the Motivation and Compensation items.

Excluded Sample

Data from the 89 subjects eliminated from consideration for the normative analysis due to neuromedical risk were analyzed for heuristic purposes with methods similar to those described for the normative sample. Descriptive statistics for this sample are presented in Tables 2 and 3. Means itemized by age, gender and age x gender are presented in Tables 4 through 6, respectively. Dependent measures were itemized utilizing the same scheme as for the normative sample. Means for Easy, Hard and total scores were consistent both with the normative sample included in the present study and with the small normative sample described by Binder & Willis (1991) (See Table 3).

Scrutiny of the means for the various scores for excluded vs. normal subjects in the present study revealed

that excluded subjects' mean scores were slightly but consistently lower than those for the normative sample by a margin of less than one half point. Several ANOVA's were conducted to determine whether *PDRT* total scores or any of the subscores for excluded subjects differed significantly from those for subjects in the normative sample. None of these tests produced significant results. Individuals eliminated from the normative sample due to neuromedical risk did not produce total scores or subscores which were significantly different than those produced by subjects included in the normative sample.

As with the normative sample, a test for homogeneity of the regressions was conducted to determine whether there were significant interactions between either or both of the between subjects factors (i.e., age and/or gender) and the medical risk scores. Several of these analyses were significant, suggesting that a CANOVA like that performed on the data from the normative sample would be uninterpretable (See Table 12). Thus, straightforward analyses of variance (ANOVA's) were employed to investigate whether there were significant differences in any of the dependent measures as a function of sex and/or age group membership. None of these analyses produced significant results (See Table 13).

Analyses were employed to assess whether increasing length of the interpolated delay period was associated with a decrement in scores (See Table 14 for a summary of

results). An initial examination of means revealed a slight increment in performance between the Easy vs. Hard items as was observed in the normative sample. However, as with the normative sample, a within-subjects multivariate analysis of variance (MANOVA) revealed that the observed increment was not significant (See Figure 3 for a graph of this trend). Another MANOVA was utilized to examine the within subjects factor of delay at three levels (5 sec., 15 sec. and 30 sec.) across Trial Blocks 1 through 3. A significant effect for delay was obtained, $F(2,176)=10.18$, $p<.001$. This effect was examined more closely utilizing successive MANOVA's to make comparisons between contiguous trial blocks. As with the normative sample, there was a significant decrement between Trial Blocks 1 and 2 consistent with the hypothesis of poorer performance with increased length of the interpolated delay period, $F(1,88)=20.23$, $p<.001$. A MANOVA was utilized to investigate whether there was a significant difference between scores on Trial Blocks 2 and 3. In contrast with the normative sample findings, these scores were not significantly different. However, consistent with the results for the normative sample, there was a significant increment in scores between the third and fourth trial block, $F(1,88)=14.02$, $p<.001$. Please see Figure 4 for a graph of mean scores as function of delay across Trial blocks 1 through 4.

The results of the Motivation item intended to measure

self-reported motivation to perform well on the task were examined in relation to *PDRT* total scores. A MANOVA including special contrasts between adjacent means was utilized to determine if there were significant differences in total *PDRT* scores in accordance with the various endorsements on the Motivation item and, if so, what the nature of these differences were. This analysis revealed that there were significant differences in total PDRT scores as a function of endorsed level of self-reported motivation toward the task, $F(4,99.55)=3.19$, $p<.05$. A closer examination of the effects by way of the special contrasts between means revealed that only one of the contiguous mean pairs was significantly different. As with the normative sample, the mean total scores for individuals responding "4" were significantly lower than the mean for individuals responding "5" ($t=-2.94$, $df=4$, $p<.01$). Scrutiny of the means revealed that the individuals endorsing "3" scored lower than the other four groups, as was the case with the normative sample. However, a comparison of the mean of the group endorsing "3" with the overall mean across groups produced nonsignificant results.

An analysis of the Compensation item was conducted to determine whether there was a relationship between the item endorsement and *PDRT* total scores. Unlike the results of this analysis for the normative sample, the MANOVA utilized to investigate this relationship for excluded subjects

produced significant results, $F(4,83)=5.22$, $p<.01$. Closer examination of the relationship between mean total scores for contiguous endorsements revealed that means associated with each of the adjacent endorsements were significantly different with one exception. Means for subjects endorsing "2" and "3" did not significantly differ. The mean total score for an endorsement of "1" was significantly higher than that for an endorsement of "2" ($t=2.25$, $df=4$, $p<.05$). The mean total score for individuals endorsing "3" was significantly higher than that for individuals endorsing "4" ($t=2.60$, $df=4$, $p<.05$). The mean total score for subjects endorsing "4" was significantly lower than that for subjects endorsing "5" ($t=-3.42$, $df=4$, $p<.001$). An additional comparison was conducted to determine the extent to which the means for the various endorsement levels deviated from the overall mean across levels. Means for subjects who endorsed "1" and "4" were significantly different from the overall mean, with means associated with endorsements of "1" being significantly higher than the overall mean ($t=3.16$, $df=4$, $p<.01$) and the mean associated with an endorsement of "4" being significantly lower ($t=-3.61$, $df=4$, $p<.001$). The mean associated with an endorsement of "5" was higher than the overall mean at a level approaching significance ($t=1.95$, $df=4$, $p=.05$). Consult Table 15 for sample means associated with the various endorsements for the Motivation and Compensation items.

Discussion

Introduction

This study provided normative data for the *Portland Digit Recognition Test*. Additionally, it investigated whether there were significant differences in test scores as a function of age, sex and medical risk status. The extent to which the length of the interpolated delay period significantly impacted scores also was examined. Several hypotheses were put forth on the basis of existing research. These will be reviewed along with supporting or disconfirming evidence from the present study. A discussion of the results for the normative sample will be presented first, followed by a discussion of the results for the excluded sample. Finally, the results will be integrated and discussed in light of Binder and Willis' (1991) research and suggestions for future research will be provided.

Normative Sample

It was predicted that the frequency distribution of the recognition scores would be negatively skewed with all subjects producing scores at or above the chance level. It was predicted that the preponderance of subjects would produce scores considerably above chance and no subjects would produce scores significantly below chance. All of these hypotheses were supported. The lowest score was 49 total correct out of a possible 72, which is considerably above the chance level. The results clearly were skewed in

a negative direction. The median score was 66 total correct, and the mode was 64.

It was predicted that there would be significant differences between scores on Easy vs. Hard items, with a significant decrement in performance exhibited between the Easy items and the Hard items (Brown, 1958; Peterson and Peterson, 1959). This hypothesis was not supported with regard to the Easy vs. Hard items; rather, there was a nonsignificant *increment* between the Easy and Hard item scores. Consistent with the hypothesis of poorer performance with increasing delay, there *was* a significant decrement in performance between Trial Blocks 1 and 2. However, there was a significant *increment* in performance between Trial Blocks 2 and 3, which is exactly counter to the hypothesis. Further, there was a significant increment in performance between Trial Blocks 3 and 4.

These results could be explained on the basis of practice effects; that is, subjects may exhibit increased skill at executing the task with repeated trials. It is possible that early in the test, the increase in length of the interpolated delay period from 5 sec. to 15 sec. was an important factor in terms of increasing the difficulty of the task. However, as the test progressed, subjects might have been able to compensate for the increased difficulty through strategies that were acquired with practice. This possibility is supported by comments made by subjects while

engaged in the task. On several occasions subjects reported discovering strategies to remember the numbers as the test progressed (e.g., remembering only the first and last digits of the strings). While not all of the strategies subjects described proved infallible, they had the potential of increasing their ability to answer correctly over time. It also is likely that a number of subjects developed strategies, but were hesitant to describe them to the examiner. Several subjects who described their strategies talked about them in terms of "beating the test" or figuring out the "trick" to the test; consequently, some subjects might have been hesitant to talk about strategies viewed in this way to the examiner. The fact that the *PDRT* consists of the same 18 five-digit target items repeated over the four trial blocks also could have contributed to practice effects. Subjects' increasing familiarity with the target items over time could have enhanced their ability to discriminate them from the distractor items. In any case, the fact that performance-*enhancing* strategies may be available to examinees certainly does not dilute the instrument's potential effectiveness in detecting malingering, rather it provides further justification to view poor performances with suspicion.

The study also investigated whether scores varied significantly as a function of age, sex or medical risk status. There were no significant differences in scores in

accordance with age group membership, which is consistent with the literature in this area. With regard to gender, an unexpected main effect was discovered on Trial Block 1. Men produced significantly higher scores than women for these items. This is a finding which will need to be replicated by future investigators to ensure that it is not an artifact of the present research (e.g., the result of sampling error, etc.). Existing research does not suggest that men will produce higher scores on short delay digit recognition items, nor does it help to elucidate why this might occur.

With regard to the medical risk scores, higher "education" risk scores were associated with lower scores on both the Easy items and Trial Block 1. The "education" risk score included four questions which asked about history of school retentions, learning problems in several subject areas, receiving special education services and referral to the school psychologist. Higher "early history" risk scores were associated with lower scores on Trial Block 1 at a level approaching significance. The "early history" risk score included six questions which asked about premature birth, birth problems, low birth weight, pregnancy complications, major illnesses before age 6 and febrile convulsions. The "total" medical risk score (i.e., the score comprised of all risk indices) also was related to scores on Trial Block 1 items. The fact that the medical risk scores were associated with a significant amount of

variation for Trial Block 1 scores only, suggests that these items may be sensitive to memory deficits associated with the various risk factors. It is possible that the medical risk covariates are significant on these earlier items and not on subsequent items, due to these earlier items being those which are most dependent on memory capacity, while later items may be more dependent on the practice effects described in the previous section. In other words, there is a slight possibility that the first trial block of the *PDRT* is a purer measure of actual memory capacity than subsequent trial blocks. During later trial blocks practice effects may become a more salient variable than memory; or at least, they may represent a confounding variable. This also may lend a modicum of support to the main effect for sex which was uncovered only on the first trial block. If men and women have actual differences in memory capacity for this type of digit recognition task, and if the aforementioned hypothesis regarding the potentially confounding nature of practice effects in later trial blocks is correct, these effects may be more likely to manifest themselves on the first trial block than on subsequent trial blocks. It should be noted that this is a very tentative hypothesis as no existing research has been found which supports the obtained effects.

Differential endorsements on the Motivation item which was intended to measure self-reported motivation to perform

well on the task were associated with significant differences in *PDRT* total scores. The pattern of effects does not conform to what might be expected on an intuitive basis (i.e., increasing total scores associated with increasing levels of self-reported motivation). The fact that subjects endorsing "3" produced total scores at a level significantly lower than the mean across all other endorsements, suggests several possible interpretations. Subjects who respond in a fashion which may reflect negativity toward the task (e.g., endorsing "1" or "2" as their level of motivation) might also be expected not to engage in a very labor intensive introspection with regard to matching their level of motivation to an endorsement on the Motivation item, while subjects reporting at least an intermediate level of motivation or higher, might be expected to expend some effort in describing their actual level of motivation. Consequently, responses of "3" through "5" might reflect more accurate estimates of motivation than responses of "1" and "2." Another possible interpretation is that individuals responding at the extremes (i.e., "1" and "2" or "4" and "5") are more susceptible to errors in reading the direction of the scale than individuals who are responding "3," which is in the middle and unaffected by directional considerations. Because the distribution was skewed in the direction of responses of "4" and "5," this source of error might have

been attenuated at the high end of the scale, while there were too few responses at the low end of the scale to provide similar correction.

Differential endorsements on the Compensation item which asks subjects to estimate the extent to which they feel they could perform better on the task if they were compensated to do so were not associated with variation in mean scores on the *PDRT*. However, an examination of the results of this item in conjunction with those from the Motivation item revealed an interesting finding with regard to individuals who endorsed "3" on the Motivation item (who were also the subjects who produced the lowest *PDRT* scores). Almost all of these individuals responded in the affirmative when asked if they could perform better at the task if they were to receive compensation, in that three of the four individuals responded "4" and the fourth responded "3" to that item. This is interesting in light of the fact that the modal response to this item was "1" with approximately 56% of the subjects responding "1." Consequently, those subjects responding "3" to the Motivation item seem to be saying that they are not performing to the best of their ability, but they could do better if they received compensation to do so.

In summary, the results suggest that subjects may be aware of their level of motivation when responding to the *PDRT*. To the extent that it seems reasonable to expect that

"awareness" of motivation would be a prerequisite for intentional "modulation" of one's level of motivation, the possibility that intentionally produced motivational deficits could be manifested on the *PDRT* is supported by the present results.

Excluded Sample

As with the normative sample, hypotheses regarding the distribution of scores were supported. The frequency distribution of total scores for the excluded sample was negatively skewed with all subjects scoring appreciably above the chance level and no subjects scoring below chance. As with the normative sample, the lowest score was 49 total correct out of 72 total possible. The median number correct was 65 and the mode was 71.

With regard to the hypothesis of poorer scores with longer interpolated delay intervals, scores for the excluded sample exactly paralleled those for the normative sample with one exception. There was not a significant increment in scores between Trial Block 2 and Trial Block 3 as was observed in the normative sample. This may be due to the smaller excluded sample size providing a less powerful test, or it may be attributable to some characteristic of the excluded sample which differs from the normative sample (e.g., neuromedical risk). If a practice effect is operative in countering the increased difficulty imposed by the longer delay interval as was hypothesized in the

previous section, it is possible that for excluded subjects this practice effect is not sufficiently powerful at that point in the test (between Trial Blocks 2 and 3) to compensate for the difficulty imposed by a longer delay interval. The possibility that the practice effect later becomes a sufficiently powerful mode of compensation is supported by the significant increment in scores observed between Trial Blocks 3 and 4.

Scores for the excluded sample did not vary significantly as a function of age group or sex for *PDRT* total scores or any of the subscores. The absence of a sex main effect on Trial Block 1 for the excluded sample may be a result of differences in this sample relative to the normative sample (e.g., due to differential neuromedical risk status), or it may be due to this sample being of insufficient size to uncover the effect, if it exists. However, the absence of this effect in the excluded sample suggests even more strongly that this finding in the normative sample should be viewed cautiously and should be subjected to attempts at replication.

Results for the Motivation item, were very similar to those for the normative sample in terms of trends; however, only one of these trends was significant for the excluded sample. Individuals endorsing "4" produced significantly lower scores than individuals endorsing "5." Means associated with endorsements of "3" through "5" again

conformed to what would be expected, with better total scores associated with higher self-reported motivational levels. In contrast, mean scores for endorsements of "1" through "3" exhibited the opposite pattern, with decreasing mean scores associated with successively higher levels of self-reported motivation. These results are not inconsistent with either of the interpretations put forth in the previous section. Again, it is possible that endorsements of "1" or "2" on the Motivation item may reflect these subjects' negativity toward the task, which could be expressed in their not expending sufficient energy introspecting about the item to provide an accurate estimate of motivation. The pattern of results also conforms to the alternate interpretation that some individuals endorsing motivational levels at the extreme ends of the item unwittingly could have reversed the direction when responding to the item.

The Compensation item which was intended to measure subjects' estimation of their ability to enhance their performance if they received financial compensation to do so was found to be associated with significant variation in *PDRT* total scores, while this was not the case in the normative sample. It is difficult to discern a meaningful pattern when scrutinizing the results across the various endorsements. Subjects endorsing "1" and "5" obtained total scores which were significantly above the overall mean on

the *PDRT*, while subjects endorsing "4" scored significantly below that level. Similar to the subjects who endorsed "3" on the Motivation item in the normative sample, the subjects who endorsed "4" on the Compensation item may be the subjects in the excluded sample of the most interest to the present research. Scrutiny of data for the subjects who endorsed "4" on the Compensation item revealed that five out of six of these subjects endorsed "4" or "5" on the Motivation item. Thus, these subjects appear to be saying on the Motivation item that they performed their best on the *PDRT* (i.e., endorsement of "5") or almost their best (i.e., endorsement of "4"), yet they scored significantly lower than the overall mean for their peers. In responding to the Compensation item, these same subjects are agreeing to a moderately strong degree that they could score better if they were paid to do so.

Within these seemingly contradictory responses may lie an important subgroup of responders; that is, individuals who say they performed as well as they could when their scores suggest otherwise, and go on a moment later essentially to admit they could do better if compensated to do so. It is as if when responding to the Motivation item that they are not attending to the apparent discrepancy between how they performed and how they might optimally perform if they applied themselves fully; however, a moment later they acknowledge that this discrepancy exists when

responding to the Compensation item.

In responding to the Motivation item, these subjects are responding in a socially desirable direction, saying they applied themselves fully when perhaps they really did not (as evidenced by their low scores). In their response to the Compensation item, these subjects seem to abandon social desirability, both by contradicting their response to the Motivation item, and by answering in a direction that would seem to be the least socially desirable (i.e., saying that they would have done even better if they'd been paid, essentially admitting that they didn't do their best, despite admonitions by the examiner to try their best). This may be further testimony to the salience of financial gain as a reinforcer of behavior in that subjects may become less concerned about social desirability when the possibility of payment is addressed, without even a promise of actual compensation.

Summary and Conclusions

Overall, the present study supports the findings from Binder and Willis' (1991) research. Risk of neurological impairment as defined by the present study was not a significant determinant of *PDRT* scores. Scores for neurologically normal subjects did not differ from subjects at risk for neurological impairment. These results are consistent with Binder and Willis' finding that subjects with well-documented brain dysfunction who were not slated

to receive compensation obtained scores which were higher than those obtained by subjects with mild head injury who stood to receive compensation for their impairment. To the extent that the excluded subjects in the present study are comparable to the subjects with mild head trauma in Binder and Willis' research, which is a debatable issue, these results support the contention that the poorer performance of the mild head trauma patients who stood to receive financial compensation for their injuries was due to motivational differences rather than neurological impairment.

Scores obtained in the present study fell slightly below those of Binder and Willis' small normative sample, but appreciably above their next highest scoring group, the "Brain Damaged-No Compensation" subjects (i.e., individuals with documented brain damage not in line for compensation) and well above the binomial probability level which would be cause for suspicion for malingering. Figure 5 presents a graph of scores for the present study along with those for Binder and Willis' various subject groups. Lines of demarcation are drawn at the level of Binder and Willis' cut-off scores (derived from the lowest scores obtained by "Brain Damaged-No Compensation" subjects) and at the scores which represent a binomial probability level which is significantly below chance (i.e., $p<.05$). The authors suggest that it is not necessary for scores on the *PDRT* to

be significantly below chance for the question of malingering to be raised, rather that scores below the cut-off level should regarded with suspicion.

Binder and Willis did not control for age and gender because their analyses suggested that there was no relationship between these variables and *PDRT* scores. The present study predominantly supported this course of action in that there were no age and gender effects, with the exception of the mean score for males on the 5 sec. items being higher than that for females. Binder and Willis did not indicate which dependent variables they analyzed as a function of age and gender. However, it is reasonable to assume that because they did not look at the 5 sec. items in isolation for any of their other analyses, this likely was also the case for the age and gender analyses. It is possible that if they had performed such analyses, they might have found significant gender effects for the 5 sec. items; however, given that there is no evidence in previous research for gender differences on this type of task, it seems at least as likely that the gender effect found in the present study is a spurious one which should be subject to replication before it is regarded with seriousness.

Binder and Willis (1991) did not address directly the impact of the length of the interpolated delay interval on performance. There was a decrement in performance between the Easy and Hard items across all subject groups in their

study. The authors affirmed the existence of this decrement by reporting in the literature accompanying the *PDRT* test materials that "many patients will perform much worse on the Hard than the Easy items (p. 4)." This clearly was not the case for the present sample, in which there was a nonsignificant increment in performance between the Easy and Hard items and a significant increment in performance between Trial Blocks 1 and 2.

There are several potential explanations for the different patterns observed in the present study as compared to Binder and Willis' research. It is possible that Binder and Willis' control group was too small to reveal this pattern. Also, subjects from Binder and Willis' sample with neurological impairment and/or "motivational differences" may exhibit a decrement in performance with an increasing delay interval for different reasons. The longer delay interval may present a greater challenge to subjects with sufficiently severe neurological impairment and/or these subjects may not exhibit the practice effects which were hypothesized to be responsible for the increment in performance exhibited in the present study. The finding that subjects in line for compensation did more poorly on the Hard items is consistent with Binder and Willis' contention that "motivationally different" subjects become less effective at the task when they are told with each successively longer interval that the test is "going to get

harder."

It seems important to note that the examiner's warning that the task would get harder in the subsequent trial block did not appear to have the effect of decreasing performances of subjects in the present study on Trial Block 3. It is not possible to predict from the present data the extent to which this suggestion might have contributed to the significant decrement in performance between Trial Blocks 1 and 2. In any case, the present results may point to an additional discriminative variable for use in detecting malingering. Binder reports in the literature accompanying the *PDRT* that "patients who are inclined to fake bad are more likely to do so as the interpolated activity interval increases (p. 2)." In contrast, the normative subjects in the present study performed better as the task progressed, rather than worse. It is possible that motivationally intact subjects with mild head trauma would exhibit the same pattern of performance. If this is found to be true, it will support the hypothesis that the decrement between Easy and Hard items observed in Binder and Willis' subjects who were in line for compensation was due to a motivational difference rather than neurological insult. Thus, observation of this pattern in a mild head trauma patient could serve as an additional signal for the clinician to further investigate the possibility of malingering.

Results from the Motivation item support Binder and

Willis' research in that endorsements on the item were significantly related to *PDRT* total scores. These results suggest that individuals may be aware of differential levels of motivation when engaged in the *PDRT*, which would seem to be a necessary prerequisite to intentional modulation of motivation.

Results from the Compensation item viewed in conjunction with Motivation item scores provide insight into distinct response patterns that may have some conceptual significance with regard to the phenomenon of malingering. While differential endorsements on the Compensation item were not significantly related to total scores for the normative sample, there were subgroup of individuals who admitted not performing their best on the Motivation item, who also did significantly more poorly than their peers, and who consistently reported that they believed they could have done better if they were paid to do so. For the excluded sample, Compensation item endorsements were significantly related to total scores. In this sample, there was an interesting subgroup who did more poorly on the task than their peers and who indicated moderately strong agreement that they could have done better if paid to do so, contradicting a previous statement that they had done as well or almost as well as they could on the task.

Any subject who knowingly did not try to do their best on the *PDRT* after the examiner emphasized the importance of

their doing so prior to the test administration could be thought of as having engaged in a subtle form of malingering. The first subgroup admits to their low level of motivation on the *PDRT* and they go on to say that the discrepancy that they are admitting exists between the ceiling of their ability level and their present level of motivation could have been reduced at least to some degree if the incentive of money had been offered. The second subgroup denies a low level of motivation on the first item, but then acknowledges its existence in responding to the second item when the incentive of money is mentioned. This could be conceptualized in terms of schemata, theoretical cognitive structures which organize incoming information. The first group of subjects could be viewed as utilizing the same schema when answering both the Motivation and Compensation item (e.g., "I didn't do that well, but I could have done better if I'd been paid.") In contrast, it appears that the second group shifts from one schema to another when moving from the Motivation item to the Compensation item. When responding to the Motivation item, these individuals might have been responding in a way that is consistent with a positive self-schema and a positive social schema (e.g., "I was asked to do well and I did well."). However, the incentive of money described in the Compensation item might have caused a shift in schemata from that just described to one which relates to personal gain

(e.g., "When I am offered money, I will work hard to get it."). This theoretical schema shift could account for the contradiction between these subjects responses on the Motivation vs. the Compensation item. They could have very different ideas about what constitutes their "best" on boring, compulsory academic hurdles vs. what constitutes their "best" on any task which will yield personal profit. Viewed in this way, the responses to the two items may not be contradictory in the sense that they may be accurate reflections of two very different cognitive sets. If this were the case, it is conceivable that these subjects could have produced these two seemingly contradictory responses without suffering pronounced cognitive dissonance, which is the usual result when an individual engages in behavior which is discrepant from their prevailing attitudes (Festinger, 1957).

Limitations of the Present Study and Directions for Future Research

Due to the difficulty obtaining subjects in sufficient numbers especially in the older age groups, alternate methods of subject recruitment were adopted over time, which introduced an uncontrolled source of variation. The fact that these subjects were not all treated in the same way in terms of incentives to participate also represents a potential confounding factor. Some subjects were paid for their participation. Receiving financial compensation might

have differentially affected these subjects performance on various aspects of the assessment. The payment might have had the effect of either improving or lowering these subjects' scores on the *PDRT* relative to those of subjects who were not paid. Also, it is possible that paid subjects might have construed the Compensation item differently from subjects who were not paid. Some might not have perceived the item with seriousness, due to the fact that they were already being paid for their participation. Fortunately, the number of subjects who either were paid for their participation, or were solicited outside the campus was small relative to the number who were recruited from university courses, lessening this source of uncontrolled variation.

Also, the time span for data collection was expanded due to limited subject availability. This could have introduced error into the study in that the preponderance of data for older age groups was collected during a different season than that for the younger subjects. It is advisable that any attempt to replicate this study be conducted at a site where subjects in all targeted age groups are available in sufficient numbers so that the data can be collected within a relatively short span of time with uniform recruitment procedures utilized during the entire period.

The only demographic variables for which data were collected in the present study were age and sex. In

retrospect, it would have been useful to collect data on years of education, years of employment, ethnicity and socioeconomic status (i.e., annual income) so that the population to which the current results generalize would be more fully defined. It would be advisable for researchers to collect data on these variables if the present study is replicated.

Useful directions for future research would include conducting similar studies with motivationally intact subjects with various levels and types of neurological impairment. When he was told of the plan to initiate the present research, Dr. Binder suggested that a similar study of developmentally disabled subjects would be interesting and of benefit to practitioners. All of these studies would serve the function of providing normative data against which the test results of different types of patients could be compared. In addition, discerning patterns of performance for different types of subjects across the increasing interpolated delay interval would help to clarify whether this may be a reliable discriminative factor for use in detecting malingering.

The hypotheses presented in the previous section with regard to the Motivation item and Compensation item are tentative and based upon post-hoc analyses of small subsets of data; however, it may be this type of qualitative analysis which will point to possible directions for future

research in this area with the eventual goal being the construction of a formal theory regarding the dynamics of malingering. As suggested in the introduction, it is often the case that the dynamics of phenomena which are associated with negative moral connotations are insufficiently examined, perhaps because there is a tendency unintentionally to vilify individuals who engage in the "bad" or "wrong" behavior and an associated inadvertent constriction of perspective on the behavior of these individuals. When engaging in research which examines the dynamics of socially undesirable behavior, it may be more productive to take an optimistic view of human beings which posits a strong positive self-actualizing tendency (e.g., Maslow, 1954; Rogers, 1957), which may for various reasons become thwarted or suppressed. When our perspective broadens to that of understanding the complexities of deviations from what is normal or desirable behavior, solutions other than finding more effective means of "identifying the culprits" may become apparent.

It has been apparent for some time that interpreting human behavior out of context can lead to erroneous conclusions, which is why systems theories that take into account multiple determinants of behavior provide promising, albeit complex, directions for psychological research (e.g., Powers, 1973). It seems that very different conclusions may be drawn as to why a patient who stands to receive financial

compensation for a minor head injury may perform less than optimally on a psychological evaluation if their entire history and current life circumstances are taken into account, than if the behavior is interpreted in isolation. The author has tested a number of head injured patients in a neuropsychological assessment lab during the past year. It has been observed that some minor head injured patients indicate *as much* (or *more*) distress about the changes in their functioning that they feel have come about as a result of their injuries, as individuals who have suffered moderate or severe trauma, who have experienced considerably greater functional losses. Young adults with minor head injuries seem to present with this level of distress most often. This apparent distress may be due, in part, to presumably greater self-awareness in younger and less impaired patients, as some describe noticing and being disturbed by subtle impairments in functioning since their injury. It also may be due to the often challenging nature of the transitional period of young adulthood. If these individuals were slated to receive compensation for their injuries, these expressions of distress might be explained in terms of their exaggerating subjective complaints to increase the probability that they will secure financial benefits. This may be true for some individuals; however, for others, it may be an inaccurate, or at least an incomplete explanation of what is occurring. It seems

possible that a patient's perception of the extent of aftereffects of a minor injury during a demanding period of life could be exaggerated due to their awareness of the demands being placed upon them, with which they must continue to cope (e.g., employment, family needs). The likelihood that individuals with minor head injuries possess more acute self-awareness, relative to patients with more pronounced injuries, may further exaggerate the extent to which these individuals feel compromised by their injury. Also, it seems that any head injury which is sufficiently serious to warrant evaluation represents an entity to which an individual could attribute a variety of difficult life circumstances, some of which even might have preceded the injury. Some individuals may credit far greater functional incapacity to their injury than is warranted and at the same time may fear that they will not receive the financial support that they believe they need or deserve due to their perceived functional losses. Several patients indicated that they feared that the tests were not "getting at" (i.e., measuring) their impairments. All of these factors could contribute to these patients' performing less than optimally during a psychological evaluation. Research aimed at systematically examining the psychological sequelae of minor head injury, including the extent to which some individuals' perception of their post-injury functional capacity may exaggerate their level of impairment, not only during

psychological assessments, but also in their daily lives, may be useful. Examining the effects of age, life stage, personality characteristics and circumstances of injury on perception of injury also may be informative. If functional deficits that result from head injuries are found to be augmented by certain individuals' perception of their injuries, it is possible that interventions could be developed to increase these individuals' productivity, both within and outside of the assessment lab.

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Table 1

Breakdown of Excluded Subjects by Age and Sex

	Males	Females	Total
Age Group A (18-20)	10	6	16
Age Group B (21-25)	14	2	16
Age Group C (26-30)	9	6	15
Age Group D (31-45)	21	21	42
All Age Groups	54	35	89

Table 2

Descriptive Statistics for *PDRT* Test Scores: Normative and Excluded Samples

Trial Blocks 1 through 4

Subject group	Trial Block 1 (5" items)			Trial Block 2 (15" items)		
	Mean	SD	Range	Mean	SD	Range
Normative Sample (n=120)	16.67	1.22	13-18	15.51	1.65	11-18
Excluded Sample (n=89)	16.49	1.38	13-18	15.52	2.22	8-18

	Trial Block 3 (30" items)			Trial Block 4 (30" items)		
	Mean	SD	Range	Mean	SD	Range
Normative Sample (n=120)	15.97	2.15	10-18	16.52	1.74	11-18
Excluded Sample (n=89)	15.76	2.15	8-18	16.52	1.87	9-18

Table 3

Descriptive Statistics for *PDRT* Test Scores: Normative and Excluded Samples and Binder's (1991) Normative Group

Easy, Hard and Total Scores

Subject group	Easy (5"and 15" items)			Hard (30" items)		
	Mean	SD	Range	Mean	SD	Range
Normative Sample	32.18	2.28	26-36	32.48	3.44	22-36
Excluded Sample	32.01	3.08	25-36	32.28	3.56	21-36
Binder's (1991) Normative Sample (n=13)	32.62	2.57	-----	32.23	4.78	-----

Subject group	Total Score		
	Mean	SD	Range
Normative Sample	64.66	4.84	49-72
Excluded Sample	64.29	5.86	49-72
Binder's (1991) Normative Sample (n=13)	64.85	6.59	-----

Table 4

Descriptive Statistics for *PDRT* Test Scores by Age Group: Normative and Excluded Sample

Trial Blocks 1 and 2

Subject group	Trial Block 1 (5" items) Mean	SD	Range	Trial Block 2 (15" items) Mean	SD	Range
Normative Sample						
Group A (18-20) (n=30)	16.57	1.19	13-18	15.17	1.64	11-18
Group B (21-25) (n=30)	16.53	1.28	14-18	15.40	1.59	12-18
Group C (26-30) (n=30)	16.47	1.33	13-18	15.80	1.77	11-18
Group D (31-45) (n=30)	17.10	.99	15-18	15.67	1.60	11-18
Excluded Sample						
Group A (18-20) (n=16)	16.31	1.58	13-18	14.88	2.90	8-18
Group B (21-25) (n=16)	16.19	1.52	13-18	15.06	2.32	11-18
Group C (26-30) (n=15)	16.33	1.11	15-18	14.87	2.17	11-18
Group D (31-45) (n=42)	16.74	1.34	13-18	16.17	1.77	12-18

table continues

Table 4

Descriptive Statistics for *PDRT* Test Scores by Age Group: Normative and Excluded Samples

Trial Blocks 3 and 4

Subject group	Trial Block 3 (30" items) Mean	SD	Range	Trial Block 4 (30" items) Mean	SD	Range
Normative Sample						
Group A (18-20) (n=30)	15.73	2.21	10-18	16.23	1.70	11-18
Group B (21-25) (n=30)	16.00	2.00	11-18	16.47	1.72	12-18
Group C (26-30) (n=30)	16.17	1.93	11-18	16.47	1.93	11-18
Group D (31-45) (n=30)	15.97	2.51	10-18	16.90	1.63	12-18
Excluded Sample						
Group A (18-20) (n=16)	15.38	2.19	12-18	17.06	1.48	13-18
Group B (21-25) (n=16)	14.81	3.04	8-18	15.56	2.03	11-18
Group C (26-30) (n=15)	15.87	1.96	12-18	16.20	1.37	9-18
Group D (31-45) (n=42)	16.24	1.69	13-18	16.79	1.65	11-18

table continues

Table 4

Descriptive Statistics for *PDRT* Test Scores by Age Group: Normative and Excluded Samples

Easy and Hard Subscores

Subject group	Easy (5" and 15" items) Mean	SD	Range	Hard (30" items) Mean	SD	Range
Normative Sample						
Group A (18-20) (n=30)	31.73	2.29	26-35	31.97	3.38	22-36
Group B (21-25) (n=30)	31.93	2.10	27-35	32.47	3.40	25-36
Group C (26-30) (n=30)	32.27	2.50	27-36	32.63	3.36	22-36
Group D (31-45) (n=30)	32.77	2.18	26-36	32.87	3.73	23-36
Excluded Sample						
Group A (18-20) (n=16)	31.19	3.78	25-36	32.44	3.10	26-36
Group B (21-25) (n=16)	31.25	3.26	26-36	30.38	4.43	23-36
Group C (26-30) (n=15)	31.20	2.62	27-35	32.07	3.90	21-36
Group D (31-45) (n=42)	32.90	2.71	27-36	33.02	3.06	26-36

table continues

Table 4

Descriptive Statistics for *PDRT* Test Scores by Age Group: Normative and Excluded Samples

Total Score

Subject group	Total Score		
	Mean	SD	Range
Normative Sample			
Group A (18-20) (n=30)	63.70	5.23	49-71
Group B (21-25) (n=30)	64.40	4.77	55-71
Group C (26-30) (n=30)	64.90	4.17	55-71
Group D (31-45) (n=30)	65.63	5.15	51-72
Excluded Sample			
Group A (18-20) (n=16)	63.62	5.64	55-72
Group B (21-25) (n=16)	61.63	7.37	51-72
Group C (26-30) (n=15)	63.27	5.64	49-70
Group D (31-45) (n=42)	65.93	5.01	53-72

Table 5

Descriptive Statistics for *PDRT* Test Scores by Gender: Normative and Excluded Samples Trial Blocks 1 through 4

Subject Group	Trial Block 1 (5" items) Mean	SD	Range	Trial Block 2 (15" items) Mean	SD	Range
Normative Group						
Males (n=60)	16.90	1.24	13-18	15.50	1.72	11-18
Females (n=60)	16.43	1.16	13-18	15.52	1.59	11-18
Excluded Group						
Males (n=54)	16.57	1.40	13-18	15.43	2.06	11-18
Females (n=35)	16.37	1.37	13-18	15.66	2.47	8-18

	Trial Block 3 (30" items) Mean	SD	Range	Trial Block 4 (30" items) Mean	SD	Range
Normative Group						
Males (n=60)	16.15	2.03	11-18	16.57	1.77	11-18
Females (n=60)	15.78	2.27	10-18	16.47	1.72	12-18
Excluded Group						
Males (n=54)	15.57	2.36	8-18	16.41	1.90	9-18
Females (n=35)	16.06	1.78	12-18	16.69	1.84	11-18

table continues

Table 5

Descriptive Statistics for *PDRT* Test Scores by Gender: Normative and Excluded Samples

Easy, Hard and Total Scores

Subject group	Easy (5" and 15" items) Mean	SD	Range	Hard (30" items) Mean	SD	Range
Normative Group						
Males (n=60)	32.40	2.32	27-36	32.72	3.28	22-36
Females (n=60)	31.95	2.24	26-36	32.25	3.61	23-36
Excluded Group						
Males (n=54)	32.00	2.91	26-36	31.98	3.79	21-36
Females (n=35)	32.03	3.36	25-36	32.74	3.17	26-36

Subject group	Total Score Mean	SD	Range
Normative Group			
Males (n=60)	65.12	4.61	49-72
Females (n=60)	64.20	5.06	51-72
Excluded Group			
Males (n=54)	63.98	5.90	49-72
Females (n=35)	64.77	5.85	53-72

Table 6

Descriptive Statistics for *PDRT* Test Scores
by Sex and by Age Group:
Normative and Excluded Samples

Total Scores

Subject group	Normative Sample Total Score			Excluded Sample Total Score		
	Mean	SD	Range	Mean	SD	Range
Group A (18-20)/ Males (n=10)	64.73	5.32	49-71	63.90	5.38	56-72
Group A (18-20)/ Females (n=6)	62.67	5.11	53-69	63.17	6.55	55-70
Group B (21-25)/ Males (n=14)	64.40	4.66	55-71	61.00	7.45	51-72
Group B (21-25)/ Females (n=2)	64.40	5.05	55-71	66.00	7.07	61-71
Group C (26-30)/ Males (n=9)	64.13	4.84	55-70	63.44	6.91	49-70
Group C (26-30)/ Females (n=6)	65.67	3.37	62-71	63.00	3.52	59-69
Group D (31-45)/ Males (n=21)	67.20	3.10	62-72	66.24	3.49	61-71
Group D (31-45) Females (n=15)	64.07	6.33	51-72	65.62	6.26	53-72

table continues

Table 6

Descriptive Statistics for *PDRT* Test Scores
by Sex and by Age Group: Normative Sample

Trial Blocks 1 and 2

Subject Group	Trial Block 1 (5" items) Mean	SD	Range	Trial Block 2 (15" items) Mean	SD	Range
Group A (18-20)/ Males (n=15)	16.93	1.03	15-18	15.13	1.81	11-18
Group A (18-20)/ Females (n=15)	16.20	1.26	13-18	15.20	1.52	13-18
Group B (21-25)/ Males (n=15)	16.60	1.40	14-18	15.33	1.91	12-18
Group B (21-25)/ Females (n=15)	16.47	1.19	14-18	15.47	1.25	14-17
Group C (26-30)/ Males (n=15)	16.60	1.55	13-18	15.73	1.94	11-18
Group C (26-30)/ Females (n=15)	16.47	1.19	14-18	15.47	1.25	14-17
Group D (31-45)/ Males (n=15)	17.47	.74	16-18	15.80	1.21	14-18
Group D (31-45) Females (n=15)	16.73	1.10	15-18	15.53	1.96	11-18

table continues

Table 6

Descriptive Statistics for *PDRT* Test Scores
by Sex and by Age Group:
Normative Sample

Trial Blocks 3 and 4

Subject group	Trial Block 3 (30" items) Mean	SD	Range	Trial Block 4 (30" items) Mean	SD	Range
Group A (18-20)/ Males (n=15)	16.00	2.10	11-18	16.67	1.80	11-18
Group A (18-20)/ Females (n=15)	15.47	2.36	10-18	15.80	1.52	13-18
Group B (21-25)/ Males (n=15)	16.13	2.00	12-18	16.33	1.59	13-18
Group B (21-25)/ Females (n=15)	15.87	2.07	11-18	16.60	1.88	12-18
Group C (26-30)/ Males (n=15)	15.80	2.40	11-18	16.00	2.42	11-18
Group C (26-30)/ Females (n=15)	16.53	1.30	15-18	16.93	1.16	15-18
Group D (31-45)/ Males (n=15)	16.67	1.68	13-18	17.27	.80	16-18
Group D (31-45) Females (n=15)	15.27	3.03	10-18	16.53	2.13	12-18

table continues

Table 6

Descriptive Statistics for *PDRT* Test Scores
by Sex and by Age Group:
Normative Sample

Easy and Hard Scores

Subject Group	Easy (5" and 15" items) Mean	SD	Range	Hard (30" items) Mean	SD	Range
Group A (18-20)/ Males (n=15)	32.07	2.31	27-35	32.67	3.39	22-36
Group A (18-20)/ Females (n=15)	31.40	2.29	26-35	31.27	3.33	24-36
Group B (21-25)/ Males (n=15)	31.93	2.46	27-35	32.47	3.14	26-36
Group B (21-25)/ Females (n=15)	31.93	1.75	30-35	32.47	3.76	25-36
Group C (26-30)/ Males (n=15)	32.33	2.72	27-36	31.80	4.23	22-36
Group C (26-30)/ Females (n=15)	32.20	2.37	29-35	33.47	2.00	30-36
Group D (31-45)/ Males (n=15)	33.27	1.62	30-36	33.93	1.91	30-36
Group D (31-45) Females (n=15)	32.27	2.58	26-36	31.80	4.77	23-36

table continues

Table 6

Descriptive Statistics for *PDRT* Test Scores
by Sex and by Age Group:
Excluded Sample

Trial Blocks 1 and 2

Subject Group	Trial Block 1 (5" items)			Trial Block 2 (15" items)		
	Mean	SD	Range	Mean	SD	Range
Group A (18-20)/ Males (n=10)	16.30	1.49	14-18	15.00	2.26	12-18
Group A (18-20)/ Females (n=6)	16.33	1.86	13-18	14.67	3.98	8-18
Group B (21-25)/ Males (n=14)	16.07	1.54	13-18	14.86	2.41	11-18
Group B (21-25)/ Females (n=2)	17.00	1.41	16-18	16.50	.71	16-17
Group C (26-30)/ Males (n=9)	16.78	1.20	15-18	15.33	2.12	12-18
Group C (26-30)/ Females (n=6)	15.67	.52	15-16	14.17	2.23	11-17
Group D (31-45)/ Males (n=21)	16.95	1.28	13-18	16.05	1.63	13-18
Group D (31-45) Females (n=15)	16.52	1.40	13-18	16.29	1.93	12-18

table continues

Table 6

Descriptive Statistics for *PDRT* Test Scores
by Sex and by Age Group:
Excluded Sample

Trial Blocks 3 and 4

Subject Group	Trial Block 3 (30" items) Mean	SD	Range	Trial Block 4 (30" items) Mean	SD	Range
Group A (18-20)/ Males (n=10)	15.80	2.30	12-18	16.80	1.81	13-18
Group A (18-20)/ Females (n=6)	14.67	1.97	12-17	17.50	.55	17-18
Group B (21-25)/ Males (n=14)	14.57	3.13	8-18	15.50	2.03	11-18
Group B (21-25)/ Females (n=2)	16.50	2.12	15-18	16.00	2.83	14-18
Group C (26-30)/ Males (n=9)	15.33	2.12	12-18	16.00	2.92	9-18
Group C (26-30)/ Females (n=6)	16.67	1.51	14-18	16.50	1.38	15-18
Group D (31-45)/ Males (n=21)	16.24	1.73	13-18	17.00	.95	15-18
Group D (31-45) Females (n=15)	16.24	1.70	13-18	16.57	2.13	11-18

table continues

Table 6

Descriptive Statistics for *PDRT* Test Scores
by Sex and by Age Group:
Excluded Sample

Easy and Hard Scores

Subject Group	Easy (5" and 15" items)			Hard (30" items)		
	Mean	SD	Range	Mean	SD	Range
Group A (18-20)/ Males (n=10)	31.30	3.20	27-36	32.60	3.69	26-36
Group A (18-20)/ Females (n=6)	31.00	4.94	25-36	32.17	2.04	30-34
Group B (21-25)/ Males (n=14)	30.93	3.32	26-36	30.07	4.46	23-36
Group B (21-25)/ Females (n=2)	33.50	2.12	32-35	32.50	4.95	29-36
Group C (26-30)/ Males (n=9)	32.11	2.67	28-35	31.33	4.64	21-36
Group C (26-30)/ Females (n=6)	29.83	2.04	27-33	33.17	2.40	30-36
Group D (31-45)/ Males (n=21)	33.00	2.41	27-36	33.24	2.43	28-36
Group D (31-45) Females (n=15)	32.81	3.04	27-36	32.81	3.63	26-36

Table 7

Test for Homogeneity of the Regressions:
Summary of F-ratios for the Normative Sample

PDRT Score	F-ratio
Total	1.11
Easy Items	1.07
Hard Items	1.01
Trial Block 1	.90
Trial Block 2	1.39
Trial Block 3	.88
Trial Block 4	1.19

Notes:

df=49

[a]$p<.01$ [b]$p<.05$ [c]$p<.10$

Table 8

Summary of F-ratios for Covariate Analyses of Variance: Normative Sample

PDRT Total scores, Easy and Hard subscores

	PDRT	Subscores	
	Total Score	Easy Score	Hard Score
Main effects			
Sex	1.83	3.88[c]	.37
Group	.73	.97	.31
2-way interactions			
Sex by Group	1.43	.41	1.60
Covariates			
Early History	3.30[c]	3.83[c]	1.59
Education	1.58	4.69[b]	.12
Mild Head Injury	.04	.63	.05
Toxic Risk	.19	1.28	.01
Anoxic Risk	.00	.03	.04
Illness	.02	.28	.30
Family History	.02	.00	.02

Notes:

df=1 for sex main effects and each of covariates
df=3 for group main effects and interaction effects

[a]$p<.01$ [b]$p<.05$ [c]$p<.10$

Table 9

Summary of F-ratios for Covariate Analyses of Variance: Normative Sample

Trial Blocks 1 through 4

	PDRT Subscores			
	Block 1 (5" delay)	Block 2 (15" delay)	Block 3 (30" delay)	Block 4 (30" delay)
Main effects				
Sex	9.35[a]	.29	.31	.00
Group	1.36	.83	.25	.69
2-way interactions				
Sex x Group	.58	.11	.96	.14
Covariates				
Early History	3.90[c]	1.57	.89	1.81
Education	8.59[a]	.78	.09	1.26
Mild Head Inj.	1.07	.12	.43	1.68
Toxic Risk	.01	2.46	.04	.00
Anoxic Risk	.87	.14	.51	.24
Illness	.03	.68	.001	.28
Family History	.12	.12	.05	.02

Notes:

df=1 for sex main effects and each of covariates
df=3 for group main effects and interaction effects

[a]$p<.01$ [b]$p<.05$ [c]$p<.10$

Table 10

Summary of F-Ratios from MANOVA's Assessing Effect of Length of Delay Interval on *PDRT* Scores: Normative Sample

Effect			F-Ratio
Within-Subjects Effect of Delay (Trial Blocks 1 - 3)			18.82[a]
Comparisons of Means			
Trial Block 1 (X=16.67)	>	Trial Block 2 (X=15.51)	49.90[a]
Trial Block 2 (X=15.51)	<	Trial Block 3 (X=15.97)	5.60[b]
Trial Block 3 (X=15.97)	<	Trial Block 4 (X=16.52)	10.44[a]
Easy (X=32.18)	<	Hard (X=32.48)	1.07

Notes:

df=1

[a]$p<.01$ [b]$p<.05$ [c]$p<.10$

Table 11

Descriptive Statistics for *PDRT* Total Scores for Motivation and Compensation Item Endorsements: Normative Sample

Motivation Item Question:

Do you feel that you performed to the best of your ability on this test?

Endorsement	Mean	SD	n
1 ("strongly disagree")	64.66	3.20	6
2	70.00	.00	1
3	57.00	6.97	4
4	63.44	5.40	29
5 ("strongly agree")	65.41	4.24	80
Whole Group Mean	64.65	4.60	120

Compensation Item Question:

Do you feel that you might have performed better if you received financial compensation to do so?

Endorsement	Mean	SD	n
1 ("strongly disagree")	65.14	4.79	67
2	64.46	3.83	15
3	64.71	5.23	14
4	63.91	6.15	12
5 ("strongly agree")	62.83	4.52	12
Whole Group Mean	64.65	4.86	120

Table 12

Test for Homogeneity of the Regressions:
Summary of F-ratios for the Excluded Sample

PDRT Score	F-ratio
Total	.05
Easy Items	2.06[b]
Hard Items	1.25
Trial Block 1	1.18
Trial Block 2	2.94[a]
Trial Block 3	.87
Trial Block 4	2.20[b]

Notes:
df=39

[a]$p<.01$ [b]$p<.05$ [c]$p<.10$

Table 13

Summary of F-ratios for Analyses of Variance: Excluded Sample

Trial Blocks 1 through 4

	PDRT Subscores			
	Block 1 (5" delay)	Block 2 (15" delay)	Block 3 (30" delay)	Block 4 (30" delay)
Main effects				
Sex	1.21	.00	.17	.00
Group	1.10	2.27	1.65	2.15
2-way interactions				
Sex by Group	.96	.53	1.25	.49

Total scores, Easy and Hard subscores

		PDRT Subscores	
	PDRT Total Score	Easy Items (5" and 15" delay)	Hard Items (30" delay)
Main effects			
Sex	.00	.26	.09
Group	2.34	2.40[c]	1.90
2-way interactions			
Sex x Group	.49	1.04	.64

Notes:

df=1 for sex main effects
df=3 for group main effects and interaction effects

[a]p<.01 [b]p<.05 [c]p<.10

Table 14

Summary of F-Ratios for MANOVA's Assessing the Effect of Length of Delay Interval on *PDRT* Scores: Excluded Sample

Effect	F-Ratio
Within-Subjects Effect of Delay (Trial Blocks 1 - 3)	10.18[a]
Comparisons of Means	
Trial Block 1 (X=16.49) > Trial Block 2 (X=15.52)	20.23[a]
Trial Block 2 (X=15.52) < Trial Block 3 (X=15.76)	1.12
Trial Block 3 (X=15.76) < Trial Block 4 (X=16.52)	14.02[a]
Easy (X=32.01) < Hard (X=32.28)	.64

Notes:

df=1

[a]p<.01 [b]p<.05 [c]p<.10

Descriptive Statistics for *PDRT* Total Scores for Motivation and Compensation Item Endorsements: Excluded Sample

Motivation Item Question:

Do you feel that you performed to the best of your ability on this test?

Endorsement	Mean	SD	n
1 ("strongly disagree")	63.66	3.21	3
2	61.00	8.88	3
3	59.75	4.99	4
4	61.78	6.22	23
5 ("strongly agree")	65.85	5.24	56
Whole Group Mean	64.29	5.58	89

Compensation Item Question:

Do you feel that you might have performed better if you received financial compensation to do so?

Endorsement	Mean	SD	n
1 ("strongly disagree")	65.93	4.98	46
2	62.63	6.22	19
3	63.55	5.17	9
4	56.16	3.81	6
5 ("strongly agree")	66.12	6.57	8
Whole Group Mean	64.32	5.38	88*

Notes:
*data was missing for one subject

Figure 1

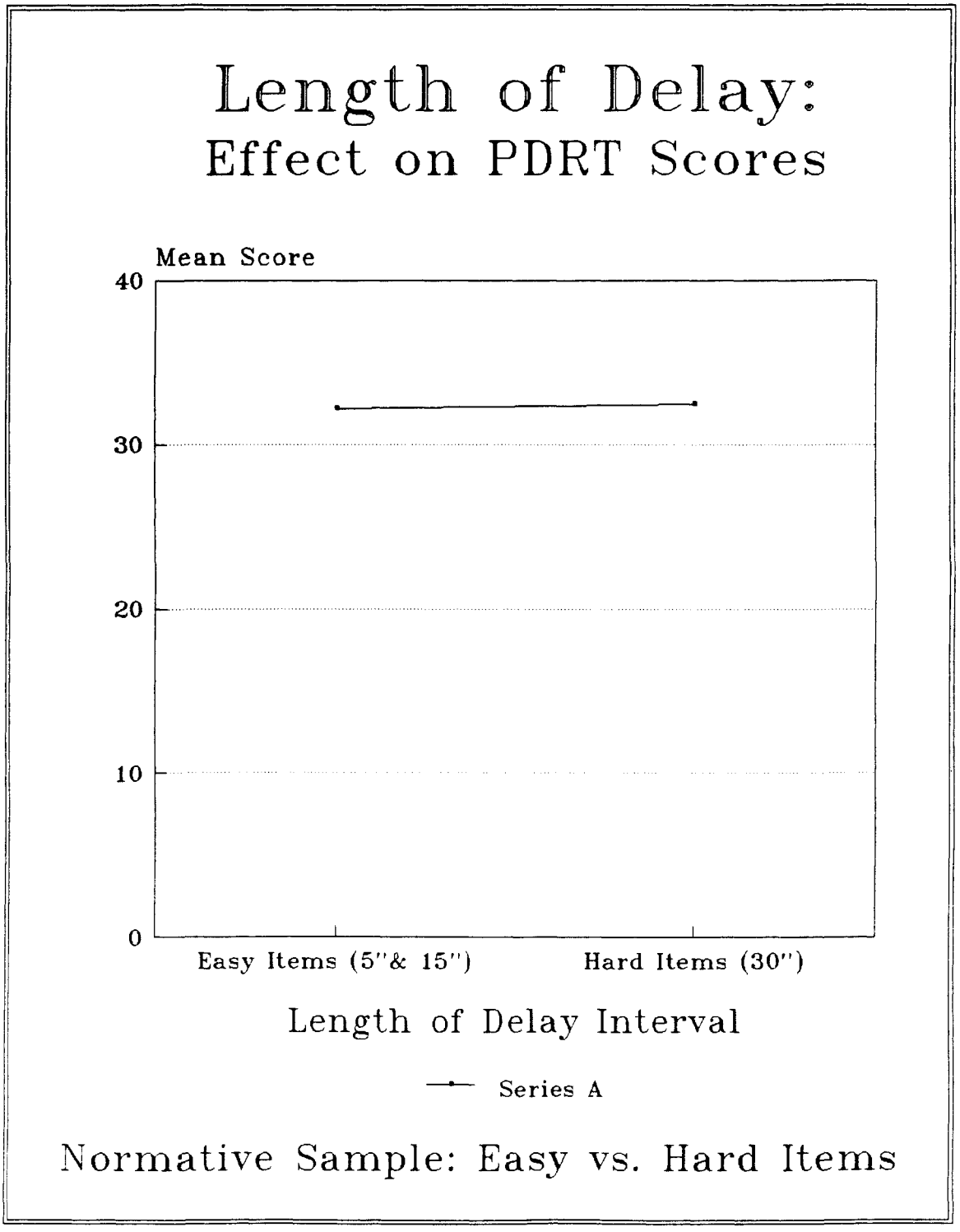

Length of Delay:
Effect on PDRT Scores
Mean Score
40
30
20
10
0
Easy Items (5"& 15")
Hard Items (30")
Length of Delay Interval
Series A
Normative Sample: Easy vs. Hard Items

Figure 2

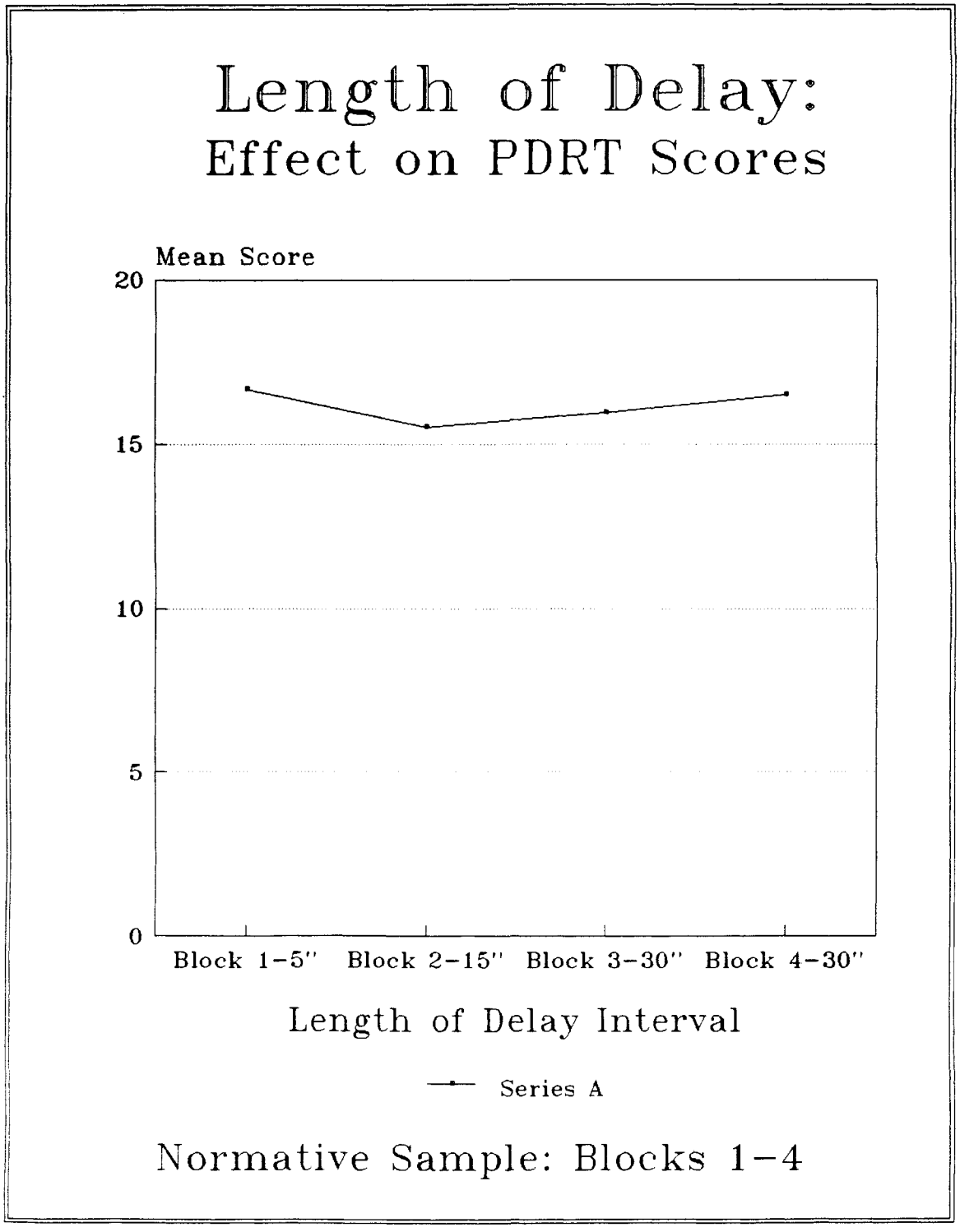

Length of Delay:
Effect on PDRT Scores
Mean Score
20
15
10
5
0
Block 1-5"
Block 2-15"
Block 3-30"
Block 4-30"
Length of Delay Interval
Series A
Normative Sample: Blocks 1-4

Figure 3

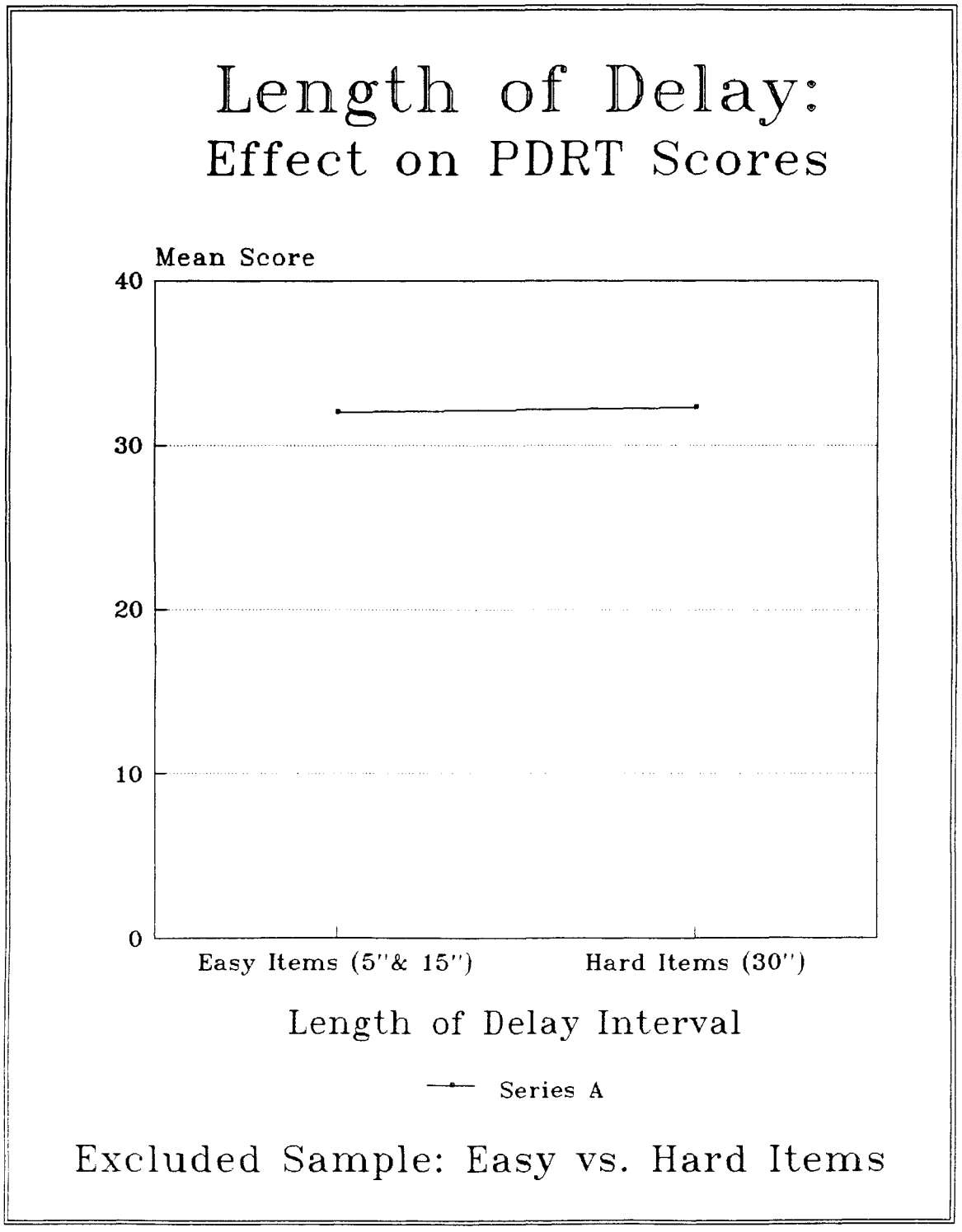

Length of Delay:
Effect on PDRT Scores
Mean Score
40
30
20
10
0
Easy Items (5"& 15")
Hard Items (30")
Length of Delay Interval
Series A
Excluded Sample: Easy vs. Hard Items

Figure 4

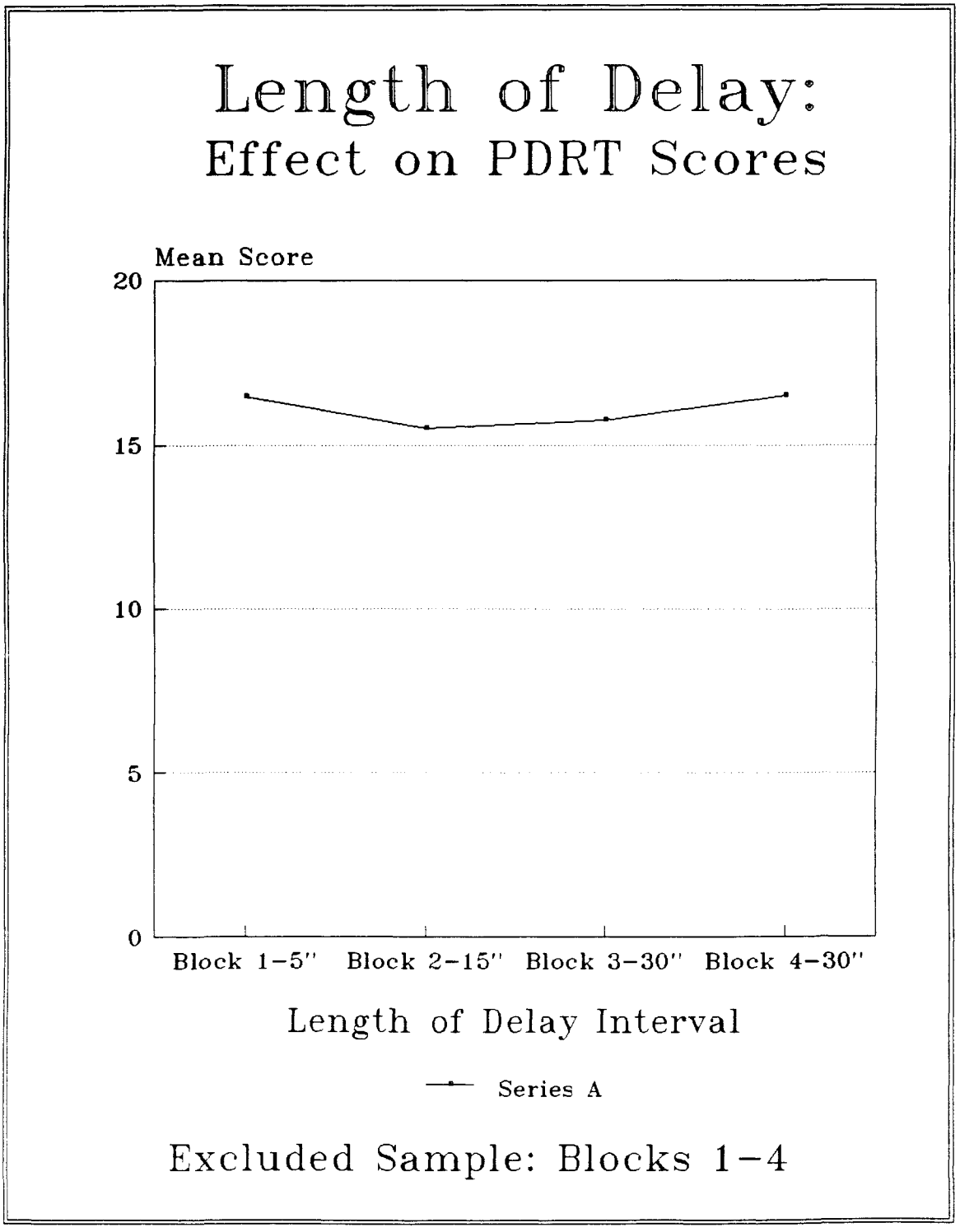
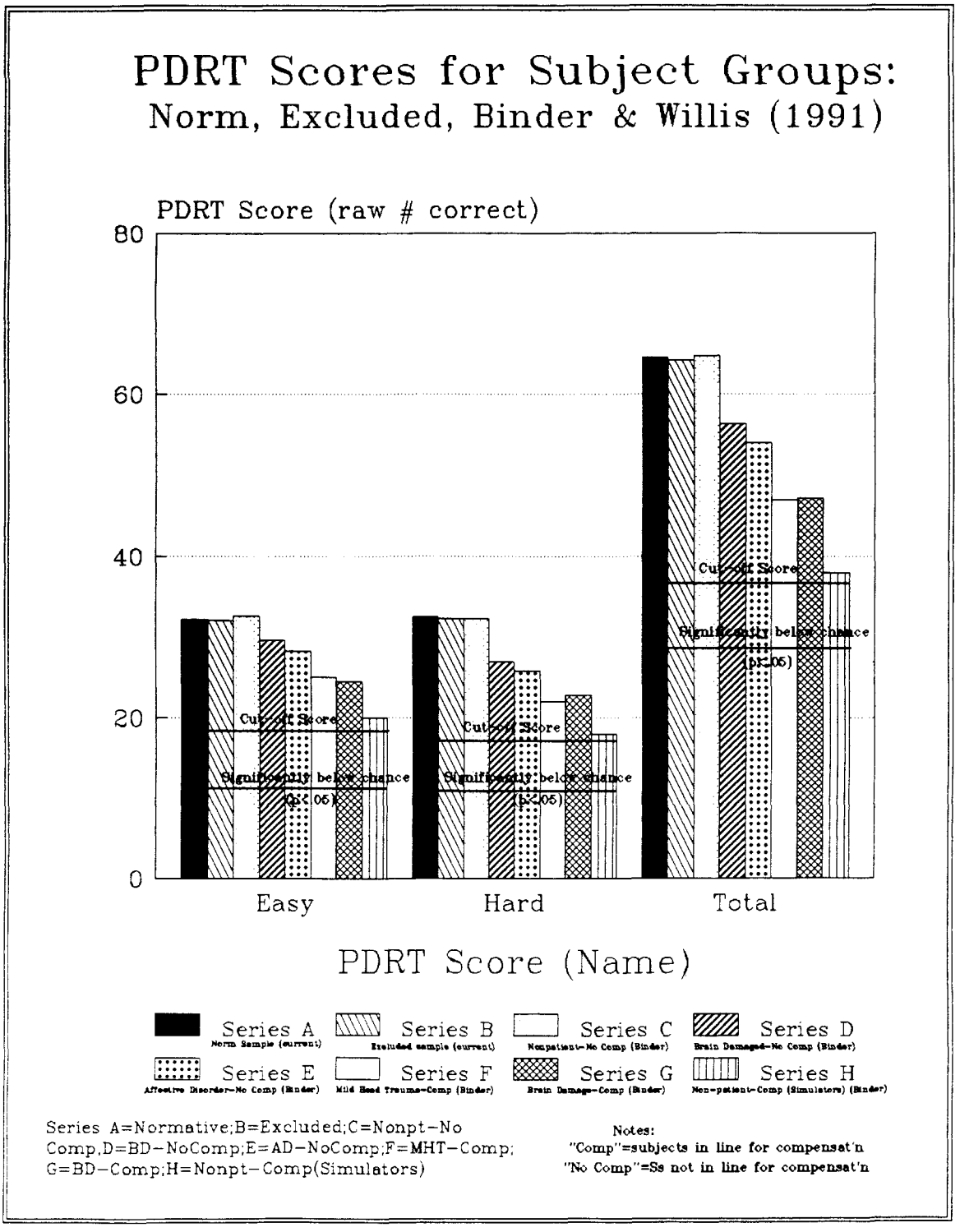

Length of Delay:
Effect on PDRT Scores
Mean Score
20
15
10
5
0
Block 1-5"
Block 2-15"
Block 3-30"
Block 4-30"
Length of Delay Interval
Series A
Excluded Sample: Blocks 1-4

Figure 5


PDRT Scores for Subject Groups:
Norm, Excluded, Binder & Willis (1991)
PDRT Score (raw # correct)
80
60
40
20
0
Cut-off Score
Significantly below chance
(p<.05)
Easy
Hard
Total
PDRT Score (Name)
Series A
Norm Sample (current)
Series B
Excluded sample (current)
Series C
Nonpatient-No Comp (Binder)
Series D
Brain Damaged-No Comp (Binder)
Series E
Affective Disorder-No Comp (Binder)
Series F
Mild Head Trauma-Comp (Binder)
Series G
Brain Damage-Comp (Binder)
Series H
Non-patient-Comp (Simulators) (Binder)
Series A=Normative;B=Excluded;C=Nonpt-No Comp;D=BD-NoComp;E=AD-NoComp;F=MHT-Comp;G=BD-Comp;H=Nonpt-Comp(Simulators)
Notes:
"Comp"=subjects in line for compensat'n
"No Comp"=Ss not in line for compensat'n

APPENDIX A
Preliminary Screening

Neurological History

	Yes	No	?
1. Have you ever been evaluated by a neurologist or neurosurgeon?	___	___	___
2.* Have you ever had any of the following tests?	___	___	___
Skull X-ray	___	___	___
EEG/BEAM	___	___	___
CAT Scan	___	___	___
MRI Scan	___	___	___
PET	___	___	___
Arteriography	___	___	___
Spinal Tap	___	___	___
Pneumoencephalogram	___	___	___
Neuropsychological Testing	___	___	___
3.* Have you ever had brain surgery?	___	___	___
4.* Have you ever been diagnosed with any of the following?			
Brain Tumor	___	___	___
Encephalitis	___	___	___
Meningitis	___	___	___
Multiple Sclerosis	___	___	___
Parkinson's Disease	___	___	___
Polio	___	___	___
Neurosyphilis	___	___	___
Stroke	___	___	___
Huntington's Chorea	___	___	___
Epilepsy	___	___	___
5.* Have you ever had any seizures?	___	___	___

Psychiatric History

	Yes	No	?
1. Have you ever had a mental health evaluation?	___	___	___
2.* Have you ever been hospitalized for mental health treatment?	___	___	___
Diagnosis?_____			
3.* Have you ever received electric shock treatments?	___	___	___

Drug History

1. Have you ever taken or been prescribed any of the following?	Yes	No	?
*Antidepressants			
Tofranil	___	___	___
Elavil	___	___	___
Vivactil	___	___	___
Sinequan	___	___	___
Aventyl	___	___	___
Pertofrane	___	___	___
Norpramin	___	___	___
Prozac	___	___	___
Desyrel	___	___	___
Ascendin	___	___	___
*Anticonvulsants			
Dilantin	___	___	___
Phenobarbital	___	___	___
Tegretol	___	___	___
Celontin	___	___	___
Clonopin	___	___	___
Mepoline	___	___	___
Mysoline	___	___	___
Zarontin	___	___	___
Others	___	___	___
*Major tranquilizers			
Thorazine	___	___	___
Stelazine	___	___	___
Prolixin	___	___	___
Mellaril	___	___	___
Haldol	___	___	___
Navane	___	___	___
Moban	___	___	___
Lithium	___	___	___
Hallucinogens	Yes	No	?
Marijuana	___	___	___
*How often? (>2x/week)_____			
LSD, Mescaline, Peyote, STP, DMT, Psilocybin	___	___	___
*How often? (>50x)_____			
*In the past month?	___	___	___
*Heroin, Opium, Hashish	___	___	___
*Cocaine, Crack, Ecstasy	___	___	___

	Yes	No	?
Inhalents			
*How often? (10x)_____			
*In the past week?	___	___	___
Hypnotics			
*How often (>50x/year) _____			
*In the past week?	___	___	___
Stimulants			
Dexedrine	___	___	___
Dexamyl	___	___	___
Biphetamine	___	___	___
Benzedrine	___	___	___
Desoxyn	___	___	___
Preludin	___	___	___
Ritalin	___	___	___
*How long? (>20 years) _____			
*In the past week?	___	___	___
Minor Tranquilizers			
Chlordiazepoxide (Librium)	___	___	___
Diazepam (Valium)	___	___	___
Oxazepam (Serax)	___	___	___
Clorazepate (Tanxene)	___	___	___
Meprobamate (Equanil, Miltown)	___	___	___
Hydroxyzine (Atarax, Vistaril)	___	___	___
Xanax (Alprazolam)	___	___	___
Lorazapam (Ativan)	___	___	___
Buspirone (Buspar)	___	___	___
*In the past week?	___	___	___
Sleeping Pills			
Seconal ("Reds")	___	___	___
Nembutal	___	___	___
Tuinal	___	___	___
Phenobarbital	___	___	___
Butabarbital	___	___	___
Amytal	___	___	___
Quaalude	___	___	___
Doriden	___	___	___
Dalmane	___	___	___
Chloral Hydrate	___	___	___
Noludar	___	___	___
Placidyl	___	___	___
Halcion	___	___	___
*In the past week?	___	___	___

Pain Drugs	Yes	No	?
Talwin	___	___	___
Morphine	___	___	___
Codeine	___	___	___
Percodan	___	___	___
Numorphan	___	___	___
Darvon, Darvocet, Darvon "N"	___	___	___
Methadon	___	___	___
Demerol	___	___	___
Dilaudid	___	___	___
Fiorinal	___	___	___
*In the past week?	___	___	___

*Have you ever been treated for alcoholism? Yes___ No___

Are you taking any medications at this time?

How much caffeine have you had today?_____

When was your last dose of caffeine?_____

At what age did you have your first, full alcoholic beverage?____

Exclusion Criteria*

Subjects were excluded from this study if any of the following
criteria were met.

1) They had been diagnosed with a neurological disease or they had undergone special neurodiagnostic tests indicating clinical suspicion of a neurological problem.

2) They had experienced major brain trauma.

3) They had been diagnosed with a psychiatric disorder.

4) They smoked or had smoked marijuana more than 2 times per week.

5) They had used hallucinogens more than 50 times per year and/or in the previous week.

6) They had ever used cocaine, crack, ecstasy, or heroin.

7) They had used stimulants more than 20 times per year and/or in the previous week.

8) They had used minor tranquilizers in the previous week.

9) They had used major tranquilizers, antidepressants, or anticonvulsants on a regular basis for at least one year preceding the study.

10) They had used inhalants more than 10 times and/or in the previous week.

11) They had suffered more than 3 minor head injuries with at least one resulting in a concussion or loss of consciousness.

12) They had ever lost consciousness for more than 5 minutes.

*Grant et al, 1978 and Grant, Adams, & Reed, 1974

APPENDIX B

Medical Risk Screening

Early History

	Yes	No	?
1. Were you born prematurely by one month or more?	___	___	___
2. Were there any birth problems?	___	___	___
3. Did you weigh 5 pounds or more at birth?	___	___	___
4. Were there any difficulties with your mothers pregnancy before your birth?	___	___	___
5. Did you have a major illness before age 6? What illness?_____	___	___	___
6. Did you ever have febrile convulsions?	___	___	___

Education

1. Were you ever held back in school?	___	___	___
2. Did you have any learning problems with reading, writing, spelling, or math?	___	___	___
3. Did you ever receive special education or special tutoring?	___	___	___
4. Were you ever referred to the school psychologist?	___	___	___

5. What was your high school grade point average?_____

9Minor Head Injury

	Yes	No	?
1. Have you ever sustained a head injury? How many?_____(>3)	___	___	___
2. Have you ever lost consciousness due to a head injury? How long?_____(>5′)	___	___	___

Toxic Risk

1. Have you ever lost consciousness due to alcohol or drug ingestion?	___	___	___
2. Have you ever had a blackout due to alcohol or drug ingestion?	___	___	___
3. Have you experienced a withdrawal due to alcohol or drug ingestion?	___	___	___

Anoxic Risk

1. Have you ever had generalized anesthesia?	___	___	___
2. Have you ever needed cardio-pulmonary resuscitation?	___	___	___
3. Have you ever had poisoning from the following?			
Carbon Monoxide	___	___	___
Metallic poisoning	___	___	___
Bromide/Pesticide	___	___	___

Illness Risk

1. Have you ever had or do you have any of the following?			
Hypertension	___	___	___
Arthritis	___	___	___
Anemia	___	___	___
Diabetes	___	___	___
Liver Disease	___	___	___
Arteriosclerosis	___	___	___
Coronary Heart Disease	___	___	___
Pulmonary Disease	___	___	___
Emphysema	___	___	___
Systemic Lupus Erthematosus (autoimmune disease)	___	___	___

	Yes	No	?
2. Have you ever had artificial respiration?	___	___	___
3. Have you ever had fevers of 104 degrees or more?	___	___	___

Family History

1. Has or does anyone in your immediate family suffer from alcoholism?	___	___	___
2. Has anyone in your immediate family ever had a neurological problem? Relationship?_____ Problem?_____	___	___	___
3. Has anyone in your immediate family ever had a psychiatric problem? Relationship?_____ Problem?_____	___	___	___
4. Has anyone in your immediate family ever had a learning disability? Relationship?_____	___	___	___

APPENDIX C

PDRT Instructions to the Patient

Laurence M. Binder c. 1989, 1990

"I want you to remember a number that I will read to you. After I read it to you, I want you to count backward from 20 to 1, like this: 20, 19, 18, and so on. Then, I'll show you a card with two numbers on it. One of them is the number I asked you to remember. Read the number you remember from the card. The first number to remember is (first item). Now count backwards from 20."

Interrupt S by presenting response card after 5 seconds for each item. If necessary, interrupt S by asking, "Which one was it?" Give feedback, "right" or "wrong" for every response.

After 18 items with 5-sec delay, say "You're doing just fine." Don't praise if S is correct on less than 12 of 18). Then say, "Now it's going to get harder. Now, after I read the number I want you to count backwards from 50. Before, I was only giving you 5 seconds to count, but now I will give you 15 seconds, so it will be harder. The first number to remember is (read first number)."

After 18 items with 15-sec delay, repeat essentially the same instructions, except that the counting is from 100, and there is a 30 sec delay. At 30-sec delay, administer 36 items in order to complete the full test.

There are only 18 different items and 36 response cards. The same items are repeated four times, and each response card is used twice on the 72 item test.

Be sure to give feedback after each response and to praise for good performance after 18 5-sec items and 18 15-sec items <u>only</u> if S is correct on at least 12. All Ss are told that the test is getting harder at the transitions from 5-sec to 15-sec and 15-sec to 30 sec.

APPENDIX D
PORTLAND DIGIT RECOGNITION TEST

	Five Second	Fifteen Second		Thirty Second			
71394							
27586							
58192							
38295							
72819							
94376							
56392							
82193							
81293							
47391							
48526							
86524							
47159							
74629							
38295							
59182							
12853							
28149							
Total Correct							

EASY _____ HARD _____

TOTAL CORRECT _____

APPENDIX E

Post-Assessment

Motivation and Compensation Items

Circle the number below each question which corresponds best with your feeling.

Please respond as honestly as possible.

1. Do you feel that you performed to the best of your ability on this test?

1	2	3	4	5
strongly disagree				strongly agree

2. Do you feel that you might have performed better if you received financial compensation to do so?

1	2	3	4	5
strongly disagree				strongly agree