ANXIETY AND TRAIL MAKING TEST SCORES IN A SAMPLE OF COCAINE ABUSERS

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Anxiety effects on the Trail Making test (TMT), a test often used for screening for cognitive impairments, were examined in a sample of cocaine abusers in drug abuse treatment programs. A mixed race sample of 4306 subjects was drawn from electronic files of data from the Drug Abuse Treatment Outcome Study (DATOS). The DATOS was a naturalistic, prospective cohort study that collected data from 1991–1993 in 96 programs in 11 cities in the United States. Data were analyzed to determine the effects of anxiety on the TMT scores A and B, and also derived indices created by adding, subtracting, multiplying, and dividing parts A and B of the TMT in this large treatment sample of cocaine abusers. The variables of sex, age, ethnicity, and education were included in analyses to control for demographic effects. The ratio derived score was the least sensitive TMT score to the effects of anxiety, but all TMT R-squares were quite small.

Keywords  anxiety, cocaine abuse, derived indices, Trail Making Test

Received 25 October 2002.

The opinions expressed herein are the views of the authors and do not necessarily reflect the official position of the Center for Substance Abuse treatment or any other part of the Department, of Health and Human Services.

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The Trail Making test (TMT; Army Individual Test Battery, 1944) is one of the most frequently administered individual neuropsychological tests (Butler, Retzlaff, & Van der Ploeg, 1991). The TMT is also very widely accepted as one of the most sensitive measures of brain damage available to neuropsychologists (Armitage, 1946; Horton, 1979; Mezzich & Moses, 1980; Norton, 1978; Reitan, 1955; Reitan, 1958; Reitan & Wolfson, 1992). The TMT has also been often used to screen substance abusers (McCaffrey, Krahula, Heimberg, Keller, & Purcell, 1988; Mezzich & Moses, 1980; Miller, 1985) for brain dysfunction. It is, of course, well known that abuse of particular drugs may produce cognitive impairments (Horton, 1996; Miller, 1985; Strickland et al., 1993).

The TMT consists of two parts labeled Trails A and Trails B. Trails A consists of 25 consecutive numbered circles that the patient connects by drawing a line through each element in the series. Trails B is a more complex task in which a series of numbers (1–13) and letters (A–L) are presented on the page enclosed within circles. The patient is required to work through the entire set alternately connecting numbers and letters (i.e., 1–A–2–B–3–C . . . L–13) until the 25th circle is reached. The patient is required to connect the circles with a pencil line as rapidly as possible. The final score for both parts is the number of seconds required to complete the task. In the course of this exercise, errors are pointed out by the examiner and the subject is redirected to the last correct circle while timing continues. Errors, therefore, count by increasing performance time (Reitan & Wolfson, 1992).

In recent years, there have been attempts to devise new indices from the TMT scores (Corrigan & Hinkeldey, 1987). One of the earliest notions was to use a difference score (i.e., subtracting part A from part B, almost always part B is greater than part A) to create a measure of cognitive functioning independent of motor speed (Heaton, Nelson, Thompson, Burks, & Franklin, 1985). Another way to control for motor speed was to divide part B by part A (Corrigan & Hinkeldey, 1987). Research efforts by Lamberty, Putnam, Chatel, Bieliauskas, and Adams (1994) found that subtracting part A from part B (a difference score) was less effective than dividing part B by part A (ratio score) in screening subjects. Later studies of normal Chinese subjects (Lee, Cheung, & Chan, 1999) and head injured
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Israeli subjects (Axelrod, Aharon-Peretz, Tomer, & Fisher, 2000) both supported the value of the ratio approach. It may be that these derived indices will prove to be more valuable than traditional measures of time to complete either part A or part B. Certainly, there is the possibility that the different indices may allow for the assessment of different aspects of TMT performance. For example, the difference score has been postulated to be a “pure” measure of cognitive ability (Heaton, Nelson, Thompson, Burks, & Franklin, 1985).

An area of relative inattention with respect to the TMT, however, has been consideration of the effects of mental health variables such as anxiety (Orsillo & McCaffrey, 1992) on TMT performance. Particularly, there has been a lack of attention to the effects of anxiety on the derived indices created by adding, subtracting, multiplying, and dividing parts A and B of the TMT.

Another issue that needs to be addressed in any discussion of neuropsychological test scores is that of appropriate demographic corrections (Heaton, Grant, & Matthews, 1991). Others have found that there is significant variability in normative data on the TMT (Soukup, Ingram, Grady, & Schiess, 1998). Demographic factors such as age, sex, education level, and ethnicity may negatively affect neuropsychological tests scores and may inappropriately suggest an impaired status (Adams, Boake, & Crain, 1982; Amante, VanHouten, Grieve, Bader, & Margules, 1977; Bernard, 1989; Campbell et al., 1996; Davies, 1968; Goul & Brown, 1970; Kennedy, 1981; Knuckle & Campbell, 1984; Lex, 1991; Pizza, 1980).

In addition, the possibility is that performance by patients who abuse a specific drug may be more strongly influenced by demographic factors such as sex, ethnicity, age and education. For example, cocaine users are more likely to have strokes and seizures than other drug abusing patients (Nalls, Disher, Daribagi, Zant, & Eisenman, 1989; Rowley, Lowenstein, Rowbottom, & Simon, 1989; Schwartz & Cohen, 1984; Wojak & Flamm, 1987; Volkow, Mullani, Gould, Adler, & Krajewski, 1988). In addition, a number of investigators (O’Malley & Gawin, 1990; Strickland et al., 1993) have reported finding neuropsychological impairments in chronic cocaine abusers.

Clearly, research is needed to investigate the effects of anxiety on both TMT standard scores (Parts A and B) and TMT derived
indices in large patient samples demonstrating cognitive impairment such as cocaine abusers. In addition, a relevant consideration would be the extent to which any anxiety effects are related to demographic variable such as age, education, sex, and ethnicity. As earlier noted, screening of substance abusers for cognitive impairment (McCaffrey, Krahula, Heimberg, Keller, & Purcell, 1988) has been an accepted clinical practice for some time. In this article, anxiety effects on six Trail Making scores were examined in a large sample of cocaine/crack abusing patients enrolled in a national sample of treatment programs.

METHOD

Subjects

A sample of 5619 males and 2902 females was drawn from electronic files of data from the Drug Abuse Treatment Outcome Study (DATOS). The DATOS was a naturalistic, prospective cohort study of adults enrolled in drug abuse treatment programs that was sponsored by the National Institute on Drug Abuse (NIDA) of the National Institutes of Health (NIH) (Horton, 1993; Fletcher, Tims, & Brown, 1997). The DATOS collected data from 1991–1993 in 96 programs in 11 cities in the United States. The DATOS intake cohort consisted of 10,010 subjects interviewed at admission to drug abuse treatment in 96 treatment programs (Flynn, Craddock, Hubbard, Anderson, & Etheridge, 1997). As the purpose of the DATOS was to evaluate the effectiveness of drug abuse treatment in typical and stable community-based drug abuse treatment programs, there may be a bias in the data collection skewed toward larger and more stable programs (Etheridge, Hubbard, Anderson, Craddock, & Flynn, 1997). Therefore, the DATOS data are most representative of subjects in the more established treatment programs in medium to large metropolitan areas in the United States. The specific cities from which drug abuse treatment subjects were drawn were: Chicago, Houston, Miami, Minneapolis, Newark, New Orleans, New York, Phoenix, Pittsburgh, Portland, and San Jose. The cities producing the largest numbers of subjects were Pittsburgh, New York, New Orleans, Chicago, and Miami.
Instrumentation

The TMT is a brief, portable and an inexpensive neuropsychological test that is frequently used as a screening measure in a wide variety of clinical and treatment settings (Horton, 1979). Like all good organic impairment screening tasks, the TMT taps a wide range of neuropsychological skills including letter and number recognition, visual scanning, cognitive flexibility, motor skill, and sequencing ability (Horton & Wedding, 1984). As noted by Struss, Bisschop, Alexander, Leving, Katz, and Izukawa (2001), the TMT is a multi-component task that can be failed for many reasons. The TMT is particularly appropriate for screening clinical subjects for cognitive impairment as it typically takes less than five minutes to administer, is in the public domain and can be administered by a trained paraprofessional (Reitan & Wolfson, 1992). In 1990, the TMT was adopted by a panel of assessment experts formed in connection with the DATOS study as a measure of cognitive impairment on the recommendation of the second author of this article, a member of the DATOS assessment expert panel (Horton, 1993).

In addition, it would probably be wise to consider a fuller range of possible arithmetic combinations of parts A and B of the TMT. Thus far, difference scores and ratio scores have been the measures studied (Heaton et al., 1985; Corrigan & Hinkeldey, 1987), including not only subtraction and division but also simple arithmetic such as addition and multiplication. Therefore, in this article four derived indices were examined, including subtraction (i.e., difference score), division (i.e., ratio score), addition (i.e., total score), and multiplication (i.e., interaction score). The addition and multiplication derived scores were devised by Dr. Roberts.

The variable of anxiety was derived from an item in the DATOS interview. The patient self-reported the number of times they experienced anxiety in the four weeks before the interview. The exact question was “# of PERIODS 4 WKS/MORE WHEN ANXIOUS” and the responses ranged from 0 to 99 or more. The authors consider the variable to reflect the number of periods, 4 weeks or longer when the subject was anxious in his/her life time. For purposes of statistical analyses, three groups were created: none, 1 or 2 times, and 3 or more times.
This is a rough measure of anxiety and is intended to be only a
gross approximation of the variable. Later studies would be needed
to determine further the effects of specific anxiety disorders such as
Panic Disorder, Generalized Anxiety Disorder, Obsessive-Compul-
sive Disorder, Simple Phobia, and Post-Traumatic Stress Disorder
(Orsillo & McCaffrey, 1992) on the TMT scores.

Procedure

This study involved secondary analysis of data collected as part of
the DATOS study from 1991–1993. The DATOS used standard test
administration procedures for data collection (Horton, 1993). The
DATOS data have been placed in electronic files on the internet in
public archives at the Substance Abuse and Mental Health Data
Archive (SAMHDA) located at http://www.icpsr.umich.edu/SAMHDA.
The available data set consisted of files with information on 8,755
subjects, identified as intake2. Files were downloaded from ftp://
ftp.icpsr.umich.edu/pub/FastTrack/. The data files were downloaded
and cleaned. An examination of the tails of TMT A and B scores
revealed approximately 1% of outliers in each tail. To facilitate data
integrity, outliers and cases with missing demographics or TMT
times were excluded from analyses, leaving 4239 cases of subjects
with a primary problem of cocaine abuse available for analyses. For
this study, secondary analyses were conducted on the data files.

Analysis of variance statistical procedures (SAS Institute, 1989)
were used to calculate the percentage of variances accounted for by
anxiety as well as selected demographic variables such as age, gen-
der, education level, and ethnicity. Separate analyses were run for
the six TMT scores.

RESULTS AND DISCUSSION

Data were analyzed to determine the effects of anxiety on scores
part A and B and four derived indices of the TMT in this large
sample of cocaine abusing patients in treatment settings. The results
quite clearly indicated that the ratio score (B/A) was least affected
by the anxiety variable. The total (A + B), and interaction (A × B/
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<th>N</th>
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<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
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<td>2.48</td>
<td>0.89</td>
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<td>1 or 2</td>
<td>519</td>
<td>32.5</td>
<td>12.5</td>
<td>75.2</td>
<td>25.5</td>
<td>42.7</td>
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<td>2.50</td>
<td>0.91</td>
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<td>43.0</td>
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<td>76.8</td>
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<td>2.44</td>
<td>0.88</td>
<td>110.5</td>
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<td>25-44</td>
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<td>13.5</td>
<td>81.1</td>
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<td>34.1</td>
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<td>65.7</td>
<td>19.6</td>
<td>37.5</td>
<td>18.1</td>
<td>2.49</td>
<td>0.86</td>
<td>94.0</td>
<td>25.4</td>
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<td>African American/Black</td>
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<td>24.3</td>
<td>43.4</td>
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<td>0.92</td>
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<td>Grade school/less</td>
<td>182</td>
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<td>12.6</td>
<td>90.4</td>
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<td>52.9</td>
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<td>2.59</td>
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<td>0.90</td>
<td>103.4</td>
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<td>38.3</td>
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<td>19.7</td>
<td>36.2</td>
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TABLE 2. Analysis of variance for TMT and indices by anxiety and demographic variables, cocaine (N = 4239)

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>A</th>
<th>B</th>
<th>A × B/100</th>
<th>A + B</th>
<th>B – A</th>
<th>A + B/A</th>
<th>F-value</th>
<th>Pr &gt; F</th>
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<td>0.0014</td>
<td>7.75</td>
<td>0.0004</td>
<td>2.58</td>
<td>0.0761</td>
<td>10.14</td>
<td>&lt;.0001</td>
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<td>Sex</td>
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<td>7.55</td>
<td>0.0060</td>
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<td>Age</td>
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<td>&lt;0.0001</td>
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<td>30.16</td>
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<tr>
<td>Residual</td>
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<td>0.081&lt;0.0001</td>
<td>0.114&lt;0.0001</td>
<td>0.050&lt;0.0001</td>
<td>0.135&lt;0.0001</td>
<td>0.118&lt;0.0001</td>
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<td>0.118&lt;0.0001</td>
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Anxiety and TMT Scores of Cocaine Abusers

100), as well as parts A and B, were all strongly significant for anxiety and the difference score (B – A) just missed significance. R squared values were also lowest (.005) for the ratio score. The R squares for part B (.114), Part A (.081), the total (.135), interaction (.118), and difference scores (.050) were consistently higher. Of course, all of the R squares were quite small (Cohen, 1988). The clear implication is the ratio score may have unique advantages as a neuropsychological measure in a sample of cocaine abusers given its relative freedom from anxiety effects.

Possible implications of the derived scores noted here lie in prediction of treatment outcomes. The possibility is that use of TMT test scores, either traditional or derived, could be of some value in predicting success in cocaine dependent outcome. The hope and expectation is the traditional and derived scores from the TMT will serve to help both evaluate the effectiveness of these programs and also serve to predict which patients might be helped by which program. Further evaluation of the traditional and derived indices from the TMT is clearly needed to assess these possibilities.

REFERENCES


