Sex differences in the prediction of academic achievement using the Children's Motivation Analysis Test

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using the Children’s Motivation Analysis Test

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Abstract

The Children's Motivation Analysis Test (CMAT), together with standardised achievement tests in mathematics and reading, was administered to a large sample of Australian elementary school children. Stepwise forward regression analyses were conducted on subsamples of 209 males and 179 females (cases with missing data previously excluded). Several of the CMAT dynamic traits significantly predicted achievement scores. The most useful predictors were conscientiousness (Superego) and family (Home) orientation. These results, based on objective motivation measurement, represent the beginnings of a new approach for research into children's motivation structure.
Introduction

In predicting academic performance from intrapersonal variables, most attention has been focused on the influence of intellectual abilities. However, as Child (1984) has shown, non-ability intrapersonal variables can account for at least as much of the achievement variance as is associated with ability factors. In particular, the role of dynamic motivation traits in academic school learning would seem to be a crucial one. Yet, it is precisely in this area (in regard to the prediction of classroom learning among primary school children) that little previous research has been undertaken. Motivational dynamic traits differ from personality traits in being sources of energy which impel an individual into action. Accordingly, they tend to fluctuate somewhat as a function of alterations in hormonal levels, arousal in the central nervous system, and changes in stimulus input.

The factor analytically derived Children's Motivation Analysis Test (CMAT) (IPAT, 1982) is a recently developed downward extension of the School Motivation Analysis Test (SMAT) (Krug et al., 1976), and also the older Motivation Analysis Test (MAT) (Cattell et al., 1964). The CMAT has the advantage of being an objective (T-data) multidimensional instrument of several important dynamic motivational traits. The CMAT is theoretically driven by the elaborate model of the dynamic calculus (Cattell, 1985; Boyle, 1988), as well as being grounded empirically in the psychometric approach of the Cattellian school of psychology. The CMAT was designed for use with primary school children, as opposed to the SMAT which covers the secondary school range, and the MAT used with adults.

The adequacy of this series of objective measures has been examined in several articles, suggesting that the instruments are sufficiently reliable and valid.
to use in both research and applied settings (Kline and Grindley, 1974; Kline, 1979; Boyle, 1983a, 1983b, 1983c, 1984, 1985a, 1985b; Boyle and Cattell, 1984; Boyle et al., 1985). Basically, these studies have found that the instruments exhibit satisfactory concrete validity (e.g., Kline and Grindley demonstrated that subjects' responses on the MAT correspond closely to their diary entries), sufficient discriminative validity (also Boyle et al. demonstrated that there is little measurement overlap/redundancy between these measures of dynamic traits, measures of personality traits, and of emotional states), and good predictive validity (e.g., Boyle and Cattell demonstrated that the dynamic trait factors respond to situational stimuli in various degrees in accord with the theory of the dynamic calculus). Reliability estimates for the dynamic traits factors have generally been quite acceptable as compared with the vast majority of psychometric instruments in the fields of personality and motivation (cf. Mitchell, 1985).

These pencil-and-paper instruments provide objective measurement wherein the relationship of the items to the factors being measured is not readily discernible to the respondent. Typical questions include for example, "How many times a year does lightning strike...?" or "An example of a citrus fruit is: A. a banana; B. an orange ...". This approach minimises the major difficulty with many self-report questionnaires, namely their item transparency and resultant proneness to response distortion (either deliberate or unconscious). In terms of classical psychoanalytic theory, much of human motivation is at the unconscious level, thereby making it unlikely that individuals would be fully aware of their motivational drives. However, use of instruments such as the MAT, SMAT and
CMAT has been shown to at least minimise response distortion (including tendencies to fake good, fake bad, or other systematic response sets).

The 10 motivational dynamic traits quantified in the CMAT include six innate, biologically based drives (ergs) as well as four culturally and experientially acquired drives relating to societal institutions such as church and family (sentiments or sems). According to Krug et al. (1976, p. 9), "wide arrays of attitudes ... have been systematically factor-analysed and found to yield unitary dynamic traits which are recognisable either as primary drivers or as acquired attitude patterns". These ergs and sentiments/sems are measured at both the unintegrated/unconscious (U) level, and at the integrated/conscious (I) level, resulting in 20 separate subscale scores. Altogether, the CMAT comprises 230 items usually presented in paper-and-pencil format, at least with older children. The items can be read out to younger children, although it is essential that in so doing the younger children fully comprehend the questions being put to them. The ergs measured in the CMAT include: Narcism (a contraction of the Freudian term, representing the drive towards self-gratification), Play (need for assimilation of environmental stimuli - often triggered by collative variability and the associated curiosity - cf. Boyle, 1983a), Fear (alertness to external dangers), Pugnacity (desire to attack others), Curiosity (search for novelty), Assertiveness (self-assertion, mastery and achievement). The sems in the CMAT include: Home (orientation towards family home life), Self-Sentiment (need for security and status), Superego (strength of conscience and associated guilt feelings), School (orientation towards schooling, incorporating both curricular and extracurricular activities).
Previous studies (e.g., Cattell and Child, 1975; Child, 1984; Boyle, 1986, 1988) have suggested the importance of motivational dynamic traits in predicting academic learning outcomes at secondary and tertiary educational levels. While non-ability intrapersonal variables often correlate only moderately with academic performance (Kline, 1979), some of the above studies have indicated that the magnitude of these correlations is increased when learning takes place under heightened emotional conditions. However, even under low-emotional activation, it would be expected that a number of CMAT dynamics might be significant predictors of classroom learning. The present study therefore served as a test of the predictive validity of the CMAT among primary school children, under normal or low emotive classroom conditions.

Method

Sample

The total sample comprised 475 Australian primary school children (Grade 6 level) enrolled in eight separate metropolitan and country schools. To ensure that the data set was complete and accurate, cases with incomplete data were deleted prior to conducting the statistical analyses. This provided a firm data set for the subsequent multiple regression analyses (see below). Accordingly, data on a sample of 388 children (209 males, 179 females) was retained for analysis. The mean age of the sample was 11.5 years (SD = 1.6 years). The children came from a diversity of socio-economic (SES) backgrounds resulting from the careful stratified random sampling in the first instance.
Design and Procedure

To avoid possible carry-over effects, the Australian Council for Educational Research (ACER) standard measures of reading and mathematics achievement were both administered on a separate testing occasion from that for the CMAT. The ACER Class Achievement Test in Mathematics (CATIM) included subtests labelled "Counting and Place Value", "Whole Numbers and Money", "Decimals and Fractions", "Spatial Relations and Measurement", and "Other Measurement Systems". The ACER Primary Reading Survey (PRS) tested both "Word Knowledge" and "Comprehension". Both achievement tests were suitable for use at Grade 6 level.

Dependent achievement variables included scores for Reading, Mathematics, and also Total Achievement (Reading and Mathematics scores combined by simple addition - shown by Boyle, 1983b, to be a useful and meaningful index of the overall level of academic achievement). These achievement scores were calculated for males and females separately (thereby enabling examination of sex differences), as well as for the combined sample.

Independent variables included the 10 CMAT subscale scores (no separation of integrated and unintegrated components was made-it was necessary to minimise the number of variables included in the subsequent multivariate regression analyses in order to obtain valid results therefrom), sex, and socio-economic status. The scores for SES levels were based on the criteria of the Victorian Ministry of Education, which took the overall occupational rating of the main "breadwinner" in each family within each school, rather than income per se, as the index of SES.
Results

The mean scores and standard deviations for each of the dependent and independent variables, for males, females and the total sample are presented in Table 1. As only Grade 6 students were included in the analyses, and since almost all of these were between 10 and 12 years of age, it was not necessary to control for age by treating it as a covariate. A multivariate analysis of variance (MANOVA) was conducted on the data in Table 1, using the SPSSX package. The multivariate statistic was highly significant (Approximate $F_{(14,373)} = 5.08, p < 0.00001$), thereby justifying the interpretation of univariate ANOVAs for each CMAT subscale across Sex. The CMAT subscales labelled Play, Fear, Pugnacity, Curiosity and Self-Sentiment all exhibited significant differences for males and females. None of the achievement variables differed significantly across sex, however.

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males</th>
<th>SD</th>
<th>Females</th>
<th>SD</th>
<th>Total Sample</th>
<th>SD</th>
<th>F (1,386)</th>
<th>p &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narcism</td>
<td>13.38</td>
<td>2.85</td>
<td>13.64</td>
<td>3.02</td>
<td>13.50</td>
<td>2.93</td>
<td>0.76</td>
<td>NS</td>
</tr>
<tr>
<td>Play</td>
<td>13.27</td>
<td>3.35</td>
<td>11.16</td>
<td>2.80</td>
<td>12.29</td>
<td>3.28</td>
<td>44.53</td>
<td>0.001</td>
</tr>
<tr>
<td>Home</td>
<td>16.30</td>
<td>3.78</td>
<td>16.06</td>
<td>3.18</td>
<td>16.19</td>
<td>3.51</td>
<td>0.45</td>
<td>NS</td>
</tr>
<tr>
<td>Fear</td>
<td>15.77</td>
<td>3.39</td>
<td>16.55</td>
<td>3.02</td>
<td>16.13</td>
<td>3.25</td>
<td>5.66</td>
<td>0.018</td>
</tr>
<tr>
<td>Pugnacity</td>
<td>16.16</td>
<td>3.51</td>
<td>17.58</td>
<td>3.19</td>
<td>16.81</td>
<td>3.43</td>
<td>17.11</td>
<td>0.001</td>
</tr>
<tr>
<td>Curiosity</td>
<td>17.38</td>
<td>3.34</td>
<td>18.17</td>
<td>2.94</td>
<td>17.74</td>
<td>3.18</td>
<td>6.10</td>
<td>0.014</td>
</tr>
<tr>
<td>Self-Sentiment</td>
<td>14.40</td>
<td>3.36</td>
<td>15.31</td>
<td>3.19</td>
<td>14.82</td>
<td>3.31</td>
<td>7.41</td>
<td>0.007</td>
</tr>
<tr>
<td>Assertiveness</td>
<td>18.45</td>
<td>3.65</td>
<td>18.53</td>
<td>3.38</td>
<td>18.49</td>
<td>3.52</td>
<td>0.04</td>
<td>NS</td>
</tr>
<tr>
<td>Superego</td>
<td>17.46</td>
<td>3.36</td>
<td>17.90</td>
<td>2.97</td>
<td>17.66</td>
<td>3.19</td>
<td>1.80</td>
<td>NS</td>
</tr>
<tr>
<td>School</td>
<td>15.07</td>
<td>2.68</td>
<td>15.08</td>
<td>2.71</td>
<td>15.07</td>
<td>2.69</td>
<td>0.00</td>
<td>NS</td>
</tr>
</tbody>
</table>

SES       | 9.69   | 5.08| 9.77    | 5.42| 9.73         | 5.23| 0.02      | NS  |
Reading   | 5.00   | 1.82| 5.30    | 2.06| 5.14         | 1.94| 1.25      | NS  |
Mathematics | 6.48   | 1.79| 6.31    | 1.69| 6.40         | 1.75| 0.20      | NS  |
Total Achievement | 11.48  | 3.15| 11.61   | 3.21| 11.54        | 3.18| 0.18      | NS  |

Notes:
Data for males is based on 209 cases; for females on 179 cases.
Only variables labelled Play, Fear, Pugnacity, Curiosity and Self-Sentiment show significant sex differences.
Maximum possible score for each CMAT subscale is 29.
In order to elucidate further the nature of the relationships between the dependent variables and the motivational dynamic traits, stepwise forward regression analyses were performed for each sex as well as the combined sample separately. Only variables which produced significant increases in the predicted variance ($R^2$) are shown in Tables 2 to 4. The multiple regression analyses were conducted using the SPSS package (Nie et al., 1975). The relatively low increases in $R^2$ were almost certainly meaningful, as opposed to being merely statistically significant. Since the CMAT was administered on a different day from the ACER achievement tests, it is likely that the correlations between the CMAT subscales and achievement scores were attenuated, as children’s dynamic motivational structures differ somewhat from day to day, and moment to moment. To this extent dynamic traits might be regarded more appropriately as specific motivational states (cf. Boyle, 1988). Accordingly, the statistically significant CMAT predictor variables would be expected to be practically meaningful contributors to the achievement variance, even though the increase in $R^2$ in some instances was not excessive.

Table 2
MULTIPLE REGRESSION ANALYSES FOR MATHEMATICS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males (N = 209)</th>
<th>Females (N = 179)</th>
<th>Combined Sample (N = 388)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multiple R</td>
<td>R^2</td>
<td>Simple R</td>
</tr>
<tr>
<td>Home</td>
<td>0.32</td>
<td>0.10</td>
<td>0.32</td>
</tr>
<tr>
<td>Superego</td>
<td>0.39</td>
<td>0.15</td>
<td>0.32</td>
</tr>
<tr>
<td>Curiosity</td>
<td>0.27</td>
<td>0.07</td>
<td>0.27</td>
</tr>
<tr>
<td>School</td>
<td>0.36</td>
<td>0.13</td>
<td>0.22</td>
</tr>
</tbody>
</table>
Notes: Only highly significant predictors included in table. For females, Home Orientation, Self-Sentiment and Pugnacity in addition were significant at better than the 10 percent level. For the combined sample, Self-Sentiment also was a significant predictor at this level. In contrast, all other CMAT variables were clearly non-significant.

In predicting Mathematics performance for males, the only significant predictors were Home and Superego, whereas for females, Curiosity, Superego and School Orientation all contributed significantly to the achievement variance. In addition, for females, Home Orientation, Self-Sentiment and Pugnacity were statistically significant predictors at the 10 per cent level or better, suggesting that no fewer than six of the 10 dynamic traits measured in the CMAT influenced Mathematics performance. Evidently, a child who is strongly attached to the parental home, and who comes from a family which encourages academic learning and achievement, is more likely to perform better in Mathematics at school, as compared with a child who either is not attached strongly to the parental home and/or comes from a family that takes a laissez-faire or even negative attitude towards scholastic achievement. On the other hand, both males and females who have superior conscience development (high Superego scores on the CMAT) also seem to achieve better in Mathematics than do children with lower scores. This suggests that the establishment of moral expectations and rules of conduct in young children is advantageous with respect to their achievement. Not unexpectedly, Curiosity was a significant predictor of performance among females. Intrinsic motivation, rather than either positive or negatively oriented extrinsic motivation (cf. Boyle, 1983a), should and evidently does influence achievement in Mathematics. Likewise, among females, School Orientation was an important contributor to Mathematics performance. Those children who enjoy
school presumably do better in this subject, and have a more positive outlook scholastically.

With regard to the prediction of Reading achievement, Home Orientation, Superego and Self-Sentiment all contributed significantly for males, while for females, Superego, Fear and Play were significant predictors, along with Curiosity which was significant at better than the 10 per cent level. Accordingly, Reading performance for males at least, is apparently enhanced if the child comes from a family which is supportive of reading and provided that he is firmly attached to the parental home; if the child has a clearly established conscience, and if he has a positive self-image. While conscience development also appears important for females in enhancing Reading performance, other motivational dynamics also appear to influence achievement. It may indeed be the case that female children acquire language fluency better through their playful interaction with others than do males in general.

Table 3
MULTIPLE REGRESSION ANALYSES FOR READING

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males (N = 209)</th>
<th>Females (N = 179)</th>
<th>Combined Sample (N = 388)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multiple R</td>
<td>R^2</td>
<td>SimpleR</td>
</tr>
<tr>
<td>Home</td>
<td>0.51</td>
<td>0.26</td>
<td>0.51</td>
</tr>
<tr>
<td>Superego</td>
<td>0.58</td>
<td>0.33</td>
<td>0.44</td>
</tr>
<tr>
<td>Self-Sentiment</td>
<td>0.59</td>
<td>0.35</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Only highly significant predictors included in table. For females, Curiosity was in addition significant at better than the 10 percent level. All other CMAT variables were non-significant.
Table 4
MULTIPLE REGRESSION ANALYSES FOR TOTAL ACHIEVEMENT

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable</th>
<th>Multiple R</th>
<th>Simple R</th>
<th>Beta Coeff.</th>
<th>F to Enter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males (N = 209)</td>
<td>Home</td>
<td>0.48</td>
<td>0.23</td>
<td>0.35</td>
<td>61.22</td>
</tr>
<tr>
<td></td>
<td>Superego</td>
<td>0.55</td>
<td>0.30</td>
<td>0.26</td>
<td>22.64</td>
</tr>
<tr>
<td></td>
<td>Curiosity</td>
<td>0.56</td>
<td>0.32</td>
<td>0.12</td>
<td>3.89</td>
</tr>
<tr>
<td>Females (N = 179)</td>
<td>Superego</td>
<td>0.37</td>
<td>0.14</td>
<td>0.32</td>
<td>28.35</td>
</tr>
<tr>
<td></td>
<td>Curiosity</td>
<td>0.43</td>
<td>0.18</td>
<td>0.21</td>
<td>9.59</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>0.45</td>
<td>0.21</td>
<td>0.16</td>
<td>5.22</td>
</tr>
<tr>
<td>Combined Sample (N = 388)</td>
<td>Superego</td>
<td>0.41</td>
<td>0.16</td>
<td>0.28</td>
<td>76.15</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>0.48</td>
<td>0.23</td>
<td>0.24</td>
<td>34.38</td>
</tr>
<tr>
<td></td>
<td>Curiosity</td>
<td>0.51</td>
<td>0.26</td>
<td>0.15</td>
<td>12.16</td>
</tr>
<tr>
<td></td>
<td>School</td>
<td>0.52</td>
<td>0.27</td>
<td>0.10</td>
<td>5.03</td>
</tr>
</tbody>
</table>

Notes: Only highly significant predictors included in table. For females, School and Play were in addition significant at better than the 10 percent level. All other CMAT variables were non-significant.

Also it is likely, on the basis of the present evidence, that females respond better academically to threats which sometimes may be imposed by teachers than do boys generally. However, this possibility would need to be assessed independently in a follow-up study.

As for the Total Achievement variable (Mathematics and Reading combined), sex differences in predictive CMAT dynamic factors were far less evident than was the case for Mathematics and Reading separately. For both males and females, Home Orientation, Curiosity and Superego were significant contributors to the academic achievement scores. It is interesting to note however, that for the girls, both School Orientation and Play contributed to performance at better than the 10 per cent level, over and above the contribution of Superego, Curiosity, and Home variables, which were all highly significant predictors of classroom learning.
To elucidate further the relationship between motivational variables and scholastic performance, separate multiple regression analyses were conducted for each of three levels of SES (1-low, 2-middle, 3-high). It was expected that SES would play an important role in educational success. However, results indicated that for Mathematics, SES appeared to have only a random effect with no clear pattern of dynamic traits emerging as significant predictors. In contrast, for Reading, the number of significant predictors was greater in every case at the highest SES level (Level 3) than at the lower levels, with the most consistent predictors being Superego and Home Orientation. Results for Reading by SES level are presented in Table 5 for males, females and the combined sample. It
appears that high SES had an important positive influence on the number of
dynamic traits brought to bear upon learning performance, at least at the upper
primary school level. These findings confirm the importance of family background
as one of the determinants of educational achievement.

**Summary and Conclusions**

Overall, a stable predictive contribution (differential validity) seems
associated with the CMAT. Superego emerged as a consistent predictor for both
Mathematics and Reading. Superego involves the attitudes, "I want always to
show self-control" and "I want to show my parents I believe in the ideals they
stand for" (Krug et al., 1976, p. 7). Evidence of Superego development in young
children would be the tendency to please one's parents (suggestive of attachment
to the parents). Also Home Orientation emerged as a significant predictor of
learning outcomes, especially for males. However, for females, Home Orientation
was only a significant predictor for those at the highest SES level. Clearly, SES
influenced achievement in Reading. Generally, the higher the SES level, the
greater was the number of dynamic traits which significantly predicted
achievement, suggesting greater educational aspirations among children from
higher SES backgrounds. Other predictive dynamic traits included Curiosity, Play,
Pugnacity, and School Orientation. Also it was apparent that for females a greater
number of dynamic traits were predictive of learning outcomes than was the case
for males. This would suggest that, in general, females might be expected to attain
superior academic results in upper primary school than would males. Clearly, the
CMAT has been shown to have some predictive value and further work to explore
its utility is indicated.
References


