Regression and Residual Analysis of the Use of the Montessori Cylinder Block as a Screening Test Instrument for Developmental Disorders (2)

- About the Relationship to the Developmental Age -

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Abstract

It was confirmed that in following four cases for children under forty-eight months of developmental age the fitted regression curve cannot be determined because the time required to inset all Montessori cylinders into the block is too varied.

1) The subjects are seventy-five children whose DQ of total areas of the Kyoto Scale of Psychological Development is above 80.

2) The subjects are sixty-five children whose DQs of three areas--Postural-Motor Area, Cognitive-Adaptive Area and Language-Social Area--of the Kyoto Scale of Psychological Development are above 80.

3) The subjects are sixty children whose DQ of total area of the Kyoto Scale of Psychological Development is above 90.

4) The subjects are forty-four children whose DQs of three areas--Postural-Motor Area, Cognitive-Adaptive Area and Language-Social Area--of the Kyoto Scale of Psychological Development are above 90.

Key words: Cylinder, Montessori, Regression, Residual

Introduction

A previous paper concerning the Montessori cylinder block B type (Azuma, 1994) examined the relationship between children’s chronological ages and the time required of children inserting all the cylinders into the block. It was determined that for children under forty-eight months of age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

This paper examines the relationship between children’s developmental ages and the time required of children inserting all the cylinders into the block.

The purpose of this paper is to confirm the following point. It is that in following four
cases for children under forty-eight months of developmental age the fitted regression curve can not be determined because the time required to inset all cylinders into the block is too varied.

(1) The subjects are seventy-five children whose DQ of total areas of the Kyoto Scale of Psychological Development is above 80.

(2) The subjects are sixty-five children whose DQs of three areas—Postural-Motor Area, Cognitive-Adaptive Area and Language-Social Area—of the Kyoto Scale of Psychological Development are above 80.

(3) The subjects are sixty children whose DQ of total area of the Kyoto Scale of Psychological Development is above 90.

(4) The subjects are forty-four children whose DQs of three areas—Postural-Motor Area, Cognitive-Adaptive Area and Language-Social Area—of the Kyoto Scale of Psychological Development are above 90.

Method

To examine the application of these regression curves to observational values the residuals were analyzed. The hypothesis that the estimate regression coefficients were zero was tested.

Results and Discussion

Case 1. The subjects are seventy-five children whose DQ of total areas of the Kyoto Scale of Psychological Development is above 80.

Figure 1 showed the nonlinear regression curve, the curve formula and the scatter diagram. Figure 2 showed the residual analysis of the nonlinear regression curve. Figure 2 showed that under forty-eight months of developmental age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Table 1 showed the result of testing the hypothesis that the estimate regression coefficients were zero. The significant probability of term X$^2$ was 17.09% and not significant. The significant probability of term X was 5.11% and not significant. But 5.11% was near to 5% and the linear regression curve was calculated.

Figure 3 showed the linear regression curve, the curve formula and the scatter diagram. Figure 4 showed the residual analysis of the linear regression curve. Figure 4 showed that under forty-eight months of developmental age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Case 2. The subjects are sixty-five children whose DQs of three areas—Postural-Motor Area, Cognitive-Adaptive Area and Language-Social Area—of the Kyoto Scale of Psychological Development are above 80.
Figure 5 showed the nonlinear regression curve, the curve formula and the scatter diagram. Figure 6 showed the residual analysis of the nonlinear regression curve. Figure 6 showed that under forty-eight months of developmental age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Table 2 showed the result of testing the hypothesis that the estimate regression coefficients were zero. The significant probability of term $X^2$ was 8.42% and not significant. The linear regression curve was calculated.

Figure 7 showed the linear regression curve, the curve formula and the scatter diagram. Figure 8 showed the residual analysis of the linear regression curve. Figure 8 showed that under forty-eight months of developmental age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Case 3. The subjects are sixty children whose DQ of total area of the Kyoto Scale of Psychological Development is above 90.

Figure 9 showed the nonlinear regression curve, the curve formula and the scatter diagram. Figure 10 showed the residual analysis of the nonlinear regression curve. Figure 10 showed that under forty-eight months of developmental age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Table 3 showed the result of testing the hypothesis that the estimate regression coefficients were zero. The significant probability of term $X^2$ was 11.86% and not significant. The linear regression curve was calculated.

Figure 11 showed the linear regression curve, the curve formula and the scatter diagram. Figure 12 showed the residual analysis of the linear regression curve. Figure 12 showed that under forty-eight months of age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Case 4. The subjects are forty-four children whose DQs of three areas—Postural-Motor Area, Cognitive-Adaptive Area and Language-Social Area—of the Kyoto Scale of Psychological Development are above 90.

Figure 13 showed the nonlinear regression curve, the curve formula and the scatter diagram. Figure 14 showed the residual analysis of the nonlinear regression curve. Figure 14 showed that under forty-eight months of developmental age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Table 4 showed the result of testing the hypothesis that the estimate regression coefficients were zero. The significant probability of term $X^2$ was 17.03% and not significant. The significant probability of term X was 5.77% and not significant. But 5.77% was near to 5% and the linear regression curve was calculated.

Figure 15 showed the linear regression curve, the curve formula and the scatter diagram. Figure 16 showed the residual analysis of the linear regression curve. Figure 16 showed that
under forty-eight months of developmental age the fitted regression curve could not be determined because the time required to inset all cylinders into the block was too varied.

Reference

Regression and Residual Analysis of the Use of the Montessori Cylinder Block as a Screening Test Instrument

Figure 1. The nonlinear regression curve, the curve formula, and the scatter diagram (75 children whose DQ of total area is above 80)

\[ Y = 0.01X^2 - 2.29X + 126.90 \]

Figure 2. The residual analysis of the nonlinear regression curve. (75 children whose DQ of total area is above 80)
Figure 3. The linear regression curve, the curve formula, and the scatter diagram (75 children whose DQ of total area is above 80).

Y = -0.70X + 83.35

Figure 4. The residual analysis of the linear regression curve. (75 children whose DQ of total area is above 80)
Figure 5. The nonlinear regression curve, the curve formula, and the scatter diagram (65 children whose DQs of three areas are above 80).

\[ Y = 0.02X^2 - 3.04X + 151.84 \]

Figure 6. The residual analysis of the nonlinear regression curve. (65 children whose DQs of three areas are above 80)
Figure 7. The linear regression curve, the curve formula, and the scatter diagram (65 children whose DQs of three areas are above 80)

Figure 8. The residual analysis of the linear regression curve. (65 children whose DQs of three areas are above 80)
Regression and Residual Analysis of the Use of the Montessori Cylinder Block as a Screening Test Instrument

Figure 9. The nonlinear regression curve, the curve formula, and the scatter diagram (60 children whose DQ of total area is above 90).

\[ Y = 0.02X^2 - 2.91X + 149.42 \]

Figure 10. The residual analysis of the nonlinear regression curve. (60 children whose DQ of total area is above 90)
Figure 11. The linear regression curve, the curve formula, and the scatter diagram (60 children whose DQ of total area is above 90).

\[ Y = -0.80X + 90.71 \]

Figure 12. The residual analysis of the linear regression curve. (60 children whose DQ of total area is above 90)
Regression and Residual Analysis of the Use of the Montessori Cylinder Block as a Screening Test Instrument

Figure 13. The nonlinear regression curve, the curve formula, and the scatter diagram (44 children whose DQs of three areas are above 90)

\[ Y = 0.02X^2 - 3.14X + 161.08 \]

Figure 14. The residual analysis of the nonlinear regression curve. (44 children whose DQs of three areas are above 90)
Figure 15. The linear regression curve, the curve formula, and the scatter diagram (44 children whose DQs of three areas are above 90)

\[ Y = -0.91X + 99.23 \]

Figure 16. The residual analysis of the linear regression curve. (44 children whose DQs of three areas are above 90)
Table 1
The Result of Testing the Hypothesis that the Estimate Regression Coefficients Were Zero (75 Children Whose DQ of total area is above 80)

<table>
<thead>
<tr>
<th>Term</th>
<th>T-value</th>
<th>Significant probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X^2$</td>
<td>1.385</td>
<td>17.09%</td>
</tr>
<tr>
<td>$X$</td>
<td>-1.987</td>
<td>5.11%</td>
</tr>
<tr>
<td>Constant</td>
<td>3.928</td>
<td>0.02%</td>
</tr>
</tbody>
</table>

Table 2
The Result of Testing the Hypothesis that the Estimate Regression Coefficients Were Zero (65 Children Whose DQs of three areas are above 80)

<table>
<thead>
<tr>
<th>Term</th>
<th>T-value</th>
<th>Significant probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X^2$</td>
<td>1.757</td>
<td>8.42%</td>
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<tr>
<td>$X$</td>
<td>-2.347</td>
<td>2.24%</td>
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<tr>
<td>Constant</td>
<td>4.117</td>
<td>0.01%</td>
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Table 3
The Result of Testing the Hypothesis that the Estimate Regression Coefficients Were Zero (60 Children Whose DQ of total area is above 90)

<table>
<thead>
<tr>
<th>Term</th>
<th>T-value</th>
<th>Significant probability</th>
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</thead>
<tbody>
<tr>
<td>$X^2$</td>
<td>1.586</td>
<td>11.86%</td>
</tr>
<tr>
<td>$X$</td>
<td>-2.177</td>
<td>3.38%</td>
</tr>
<tr>
<td>Constant</td>
<td>3.935</td>
<td>0.02%</td>
</tr>
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</table>

Table 4
The Result of Testing the Hypothesis that the Estimate Regression Coefficients Were Zero (44 Children Whose DQs of three areas are above 90)

<table>
<thead>
<tr>
<th>Term</th>
<th>T-value</th>
<th>Significant probability</th>
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<tr>
<td>$X^2$</td>
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<td>17.03%</td>
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<tr>
<td>$X$</td>
<td>-1.955</td>
<td>5.77%</td>
</tr>
<tr>
<td>Constant</td>
<td>3.544</td>
<td>0.01%</td>
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