We developed a method to make diagnoses of anxiety using criteria provided by Phillip. Would it also be possible to make such diagnoses based on a much more simple scheme, a simple cutoff point for total SAD score? Phillip suggested ROC analysis to investigate this. The missing data are the “gold standard” classifications – that is, for each case, is the person actually anxious or not (as determined by a reliable clinical assessment). While we may have gold standard data in the future, we do not now. To illustrate the ROC analysis, I have substituted for the gold standard classifications the classification made using Phillip’s criteria.

I wrote, from SAS, the relevant data to a plain text file which I imported to SPSS. The ROC analysis was conducted this way:

Here is the output:

<table>
<thead>
<tr>
<th>Case Processing Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
</tr>
<tr>
<td>Positive</td>
</tr>
<tr>
<td>Negative</td>
</tr>
</tbody>
</table>
The green line represents chance classification. The blue line illustrates the tradeoff between sensitivity (what proportion of anxious persons are correctly classified as anxious) and specificity (what proportion of non-anxious persons are correctly classified) as the cutoff point is changed. If you consider sensitivity and specificity equally important, you will want a cutoff that corresponds to a point on the blue line that is as close to the upper left corner as possible. The red dots on the figure above represent my eyeball location of that point, with sensitivity and specificity of about 85%.

### Area Under the Curve

Test Result Variable(s): SAD_Total

<table>
<thead>
<tr>
<th>Area</th>
<th>Std. Error</th>
<th>Asymptotic Sig.</th>
<th>Asymptotic 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.930</td>
<td>.020</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>.891</td>
<td>.970</td>
<td></td>
</tr>
</tbody>
</table>

The better the diagnostic test (SAD_Total), the greater will be the AUC (area under the curve). A value of .5 indicates that the diagnostic test is useless. Values above .9 are considered excellent.

The table below gives sensitivity and specificity for a wide range of cutoff points. I have culled it so it fits on the next page of this document.
With a cutoff point of 53.5, sensitivity is .826 and specificity is \((1 - .163) = .837\). With a cutoff point of 54.5, sensitivity remains at .826 and specificity increases to .855. Given that SAD_Total scores are integer, I’d set the cutoff at 54.

<table>
<thead>
<tr>
<th>Positive if Greater Than or Equal To</th>
<th>Sensitivity</th>
<th>1 - Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>.50</td>
<td>1.000</td>
<td>.971</td>
</tr>
<tr>
<td>37.50</td>
<td>1.000</td>
<td>.285</td>
</tr>
<tr>
<td>38.50</td>
<td>.957</td>
<td>.262</td>
</tr>
<tr>
<td>43.50</td>
<td>.913</td>
<td>.221</td>
</tr>
<tr>
<td>50.00</td>
<td>.870</td>
<td>.174</td>
</tr>
<tr>
<td>52.00</td>
<td>.870</td>
<td>.163</td>
</tr>
<tr>
<td>53.50</td>
<td>.826</td>
<td>.163</td>
</tr>
<tr>
<td>54.50</td>
<td>.826</td>
<td>.145</td>
</tr>
<tr>
<td>55.50</td>
<td>.783</td>
<td>.140</td>
</tr>
<tr>
<td>60.50</td>
<td>.739</td>
<td>.105</td>
</tr>
<tr>
<td>61.50</td>
<td>.739</td>
<td>.093</td>
</tr>
<tr>
<td>63.50</td>
<td>.739</td>
<td>.081</td>
</tr>
<tr>
<td>65.50</td>
<td>.739</td>
<td>.076</td>
</tr>
<tr>
<td>67.00</td>
<td>.739</td>
<td>.070</td>
</tr>
<tr>
<td>68.50</td>
<td>.696</td>
<td>.070</td>
</tr>
<tr>
<td>69.50</td>
<td>.696</td>
<td>.064</td>
</tr>
<tr>
<td>71.50</td>
<td>.609</td>
<td>.058</td>
</tr>
<tr>
<td>73.50</td>
<td>.609</td>
<td>.052</td>
</tr>
<tr>
<td>74.50</td>
<td>.565</td>
<td>.052</td>
</tr>
<tr>
<td>78.50</td>
<td>.435</td>
<td>.047</td>
</tr>
<tr>
<td>79.50</td>
<td>.435</td>
<td>.041</td>
</tr>
<tr>
<td>82.00</td>
<td>.391</td>
<td>.035</td>
</tr>
<tr>
<td>85.50</td>
<td>.348</td>
<td>.035</td>
</tr>
<tr>
<td>88.00</td>
<td>.348</td>
<td>.029</td>
</tr>
<tr>
<td>89.50</td>
<td>.348</td>
<td>.023</td>
</tr>
<tr>
<td>92.00</td>
<td>.304</td>
<td>.023</td>
</tr>
<tr>
<td>94.50</td>
<td>.261</td>
<td>.017</td>
</tr>
<tr>
<td>96.00</td>
<td>.261</td>
<td>.012</td>
</tr>
<tr>
<td>97.50</td>
<td>.261</td>
<td>.006</td>
</tr>
<tr>
<td>101.00</td>
<td>.217</td>
<td>.000</td>
</tr>
<tr>
<td>107.00</td>
<td>.174</td>
<td>.000</td>
</tr>
<tr>
<td>111.50</td>
<td>.130</td>
<td>.000</td>
</tr>
<tr>
<td>115.00</td>
<td>.087</td>
<td>.000</td>
</tr>
<tr>
<td>126.50</td>
<td>.043</td>
<td>.000</td>
</tr>
<tr>
<td>137.00</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Anxiety * SAD_Anx Crosstabulation</td>
<td>SAD_Anx Predicted From Total_SAD Score</td>
<td>Total</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Count</td>
<td>144</td>
<td>28</td>
</tr>
<tr>
<td>% within Anxiety</td>
<td>83.7%</td>
<td>16.3%</td>
</tr>
<tr>
<td>% within SAD_Anx</td>
<td>97.3%</td>
<td>59.6%</td>
</tr>
<tr>
<td>Count</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>% within Anxiety</td>
<td>17.4%</td>
<td>82.6%</td>
</tr>
<tr>
<td>% within SAD_Anx</td>
<td>2.7%</td>
<td>40.4%</td>
</tr>
<tr>
<td>Count</td>
<td>148</td>
<td>47</td>
</tr>
<tr>
<td>% within Anxiety</td>
<td>75.9%</td>
<td>24.1%</td>
</tr>
<tr>
<td>% within SAD_Anx</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Sensitivity: Of the 23 with (Phillip’s) anxiety, 19 were correctly classified (from the SAD_Total score) to have anxiety, \( \frac{19}{23} = 82.6\% \).

Specificity: Of the 172 without (Phillip’s) anxiety, 144 were correctly classified, \( \frac{144}{172} = 83.7\% \).

False Positive Rate: Of the 47 for whom anxiety was predicted, 28 did not have (Phillip's) anxiety, for a false positive rate of \( \frac{28}{47} = 59.6\% \).

False Negative Rate: Of the 148 predicted not to have anxiety, 4 did have (Phillip’s) anxiety, for a false negative rate of \( \frac{4}{148} = 2.7\% \).

SAS

Also useful for helping decide where to put the cut-point is the ctable output from PROC LOGISTIC. The culled table is presented on the next page.
As you can see, the cutoff, in terms of the predicted probability that the case has anxiety, is about 90%. Here are the estimated model parameters:

### Analysis of Maximum Likelihood Estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DF</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Wald</th>
<th>Pr &gt; ChiSq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1</td>
<td>5.5852</td>
<td>0.8178</td>
<td>46.6408</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>SAD_Total</td>
<td>1</td>
<td>-0.0679</td>
<td>0.0119</td>
<td>32.3723</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

For a case with SAD_Total = 54 the predicted odds of anxiety is $e^{5.5852 - (0.0679)(54)} = 6.8114$. Converting to a probability, that is .87.

Here is the ROC for predicting Depression from SAD_Total:
## Area Under the Curve

Test Result Variable(s): SAD_Total

<table>
<thead>
<tr>
<th>Area</th>
<th>Std. Error</th>
<th>Asymptotic Sig.</th>
<th>Asymptotic 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>.954</td>
<td>.016</td>
<td>.000</td>
<td>.923</td>
</tr>
</tbody>
</table>

## Coordinates of the Curve

Test Result Variable(s): SAD_Total

<table>
<thead>
<tr>
<th>Positive if Greater Than or Equal To</th>
<th>Sensitivity</th>
<th>1 - Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.50</td>
<td>1.000</td>
<td>.506</td>
</tr>
<tr>
<td>43.50</td>
<td>.897</td>
<td>.199</td>
</tr>
<tr>
<td>52.00</td>
<td>.862</td>
<td>.139</td>
</tr>
<tr>
<td>56.50</td>
<td>.828</td>
<td>.102</td>
</tr>
<tr>
<td>63.50</td>
<td>.793</td>
<td>.048</td>
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<td>65.50</td>
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</tr>
<tr>
<td>67.00</td>
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</tr>
<tr>
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<tr>
<td>69.50</td>
<td>.724</td>
<td>.036</td>
</tr>
<tr>
<td>71.50</td>
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<td>.030</td>
</tr>
<tr>
<td>73.50</td>
<td>.655</td>
<td>.024</td>
</tr>
<tr>
<td>74.50</td>
<td>.621</td>
<td>.024</td>
</tr>
<tr>
<td>76.00</td>
<td>.552</td>
<td>.024</td>
</tr>
</tbody>
</table>

Karl L. Wuensch, January, 2016