Guide for How to Use the ESS-Multinomial Reference Tables in Four Steps

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Multinomial tables exist for grand total scores and multiplicity corrected subtotals for test formats with 2, 3, and 4 RQs, with and without the vasomotor sensor. Use of the multinomial reference tables difference slightly from the use of the original ESS reference tables (for which the statistical result can be thought of only as an estimate of error and not as a direct estimate of the deception or truth-telling). Statistical results using the ESS-M and Bayesian analysis can be thought of as a posterior estimate of deception or truth-telling.

Before conducting the exam

1. **Locate the ESS-M reference table for the number of RQs in the test question format**
   - ESS-M tables are a form of likelihood function (i.e., a device to obtain a statistical value associated with the test scores).
   - ESS-M statistical values can be expressed using a number of different statistical metrics
     - ***ways***: the number of possible ways to combine all the sensor scores to observe each possible score
     - ***pmf***: probability mass function is the proportion of ways to achieve each possible score compared to all possible ways for all possible scores.
     - ***cdf***: cumulative distribution function is the cumulative sum of the values of the PMF.
     - ***cdfContCor***: continuity-corrected cumulative distribution function is used to locate the probability value in middle of the cell instead of the edges to allow a more straightforward discussion of the odds - similar to sports betting wherein a bet is place on a point value such as 55.5, even though 1⁄2 points are never scored in reality, causing the actual point score to always be over or under the target value.
     - ***odds***: are calculated as p / (1-p) using the continuity corrected cdf. Odds can be thought of as the odds of observing a deceptive or truthful score under the null-hypothesis to the analytic theory of the polygraph[1]. The odds of deception or odds of truth-telling is the likelihood function for a Bayesian analysis of the posterior probability or posterior odds of deception or truth-telling. The odds can also be though of as the Bayes factor or the posterior odds when the prior odds are 1 to 1.
     - ***oddsLL05***: is the .05th percentile lower-limit of the Bayesian credible interval for the posterior odds when the prior odds are 1 to1. The credible interval treats the unknown parameter of interest (i.e., deception or truth-telling) as a probability value for which the test data are a fixed basis of information to calculate the expected range within which the parameter can be assumed to exist with some quantifiable estimate of the likelihood or credibility associated with the result or conclusion. The .05th percentile lower limit is analogous to the alpha level in inferential statistical testing, and indicates the level at which the likelihood is significant that the posterior odds exceed the prior odds.
2. **Determine the alpha boundaries and numerical cutscores.**
   - Alpha is commonly set at .05
     - Alpha is an administrative decision, often not determined by field practitioners
       - Alpha = .01 for increased precision (may increase inconclusive results)
       - Alpha = .10 for decreased inconclusive results (may increase error rate)

1 The analytic theory of the polygraph holds that greater changes in physiological activity are loaded at different types of test stimuli as a function of deception or truth-telling in response to the relevant target stimuli (see Nelson, 2016 for discussion of the analytic theory of the polygraph test).

- Use the *oddsLL05* column and locate the largest lower limit value that is greater than the prior odds (prior is usually 1 to 1, unless other high quality information is available). Then determine the cutscore by selecting the value from the *score* column. Locate the lower limit odds and cutscores for deceptive and truthful scores. Use the table for a single RQ to determine subtotal cutscores using the columns for the multiplicity-corrected odds with 2, 3 and 4 RQs.

After conducting and scoring the exam

3. **Calculate the posterior probability, and lower limit using the correct reference table for the number of RQs in the test format.**
   - Using the correct reference table, locate the row for the grand total in the *score* column and determine the Bayes factor or posterior odds using the same row in the *odds* column.
     - Bayes factor is the posterior odds with an equal prior
     - Use Bayes theorem to calculate the posterior odds for any other prior
   - Use the table for a single RQ when using subtotal scores. The *odds* and *oddsLL05* columns include statistical correction for both truthful and deceptive classifications.
4. **Interpret the result (translate the numerical and statistical result into usable human language).**
   - A complete interpretation of the test result will provide sufficient information to reproduce the analytic conclusion.
     - Method of analysis
     - Input parameters for probabilistic inference (i.e., prior and alpha)
     - An explanation of the procedural decision rules used to obtain the probabilistic and categorical results from the grand total or subtotal scores.
     - Numerical scores (grand total or subtotal) used to determine the probabilistic and categorical result
     - Bayes factor – (allows recalculation of the analytic results with a different prior and alpha)
     - Posterior odds of deception or truth-telling (or posterior probability)
     - Lower limit of the Bayesian credible interval for the posterior odds of deception or truth-telling (or posterior probability)
     - Use of any statistical correction for multiplicity when using subtotal scores
     - An explanation of the empirical and scientific meaning of the test result.
     - Categorical result (DI/SR or NDI/NSR)

Reference tables can be obtained online at: http://www.polygraph.org/resources/

References

Nelson, R. (2017). Multinomial reference distributions for the Empirical Scoring System. *Polygraph and Forensic Credibility Assessment 46(2),* 81-115.

Nelson, R. (2016). Scientific (analytic) theory of polygraph testing. *APA Magazine, 49(5),* 69-82.