Factor Analysis at 100:

A Timeline of Selected Publications and Events

Spearman, C. General intelligence, objectively determined and measured. *American Journal of Psychology*

Charles Spearman receives Ph.D. Under Wundt at Leipzig

Charles Spearman returns to England and takes position at University College London

Burt, C. Experimental tests of general intelligence. *British Journal of Psychology*

Hart, B., & Spearman, C. General ability, its existence and nature. *British Journal of Psychology*

L. L. Thurstone joins faculty at University of Chicago

Spearman, C. *The Abilities of Man*

Dodd, S. C. The theory of factors. *Psychological Review*

Kelley, T. *Crossroads in the Mind of Man*

L. L. Thurstone establishes Psychometric Laboratory at University of Chicago

Thurstone, L. L. Multiple factor analysis. *Psychological Review*

Charles Spearman retires from University College London

First electric adding machine (Victor 511S-12)

Brown, W., & Stephenson, W. A test of the theory of two factors. *British Journal of Psychology*

Hotelling, H. Analysis of a complex of statistical variables into principal components. *Journal of Educational Psychology*

Thurstone, L. L. The Theory of Multiple Factors

L. L. Thurstone serves as President of American Psychological Association

Thurstone, L. L. The vectors of mind. *Psychological Review*

Garnett, H. E. The two-factor theory and its criticism. *Psychological Review*

Thurstone, L. L. *The Vectors of Mind*

February: First organizational meeting of Psychometric Society

Cattell, R. B. "Parallel proportional profiles" and other principles for determining the choice of factors by rotation. *Psychometrika*

September 17: Charles Spearman dies at age 82 in London

First general-purpose electronic computer (ENIAC)

Cattell, R. B., Cattell, A. K. S., & Rhymer, R. M. P-technique demonstrated in determining psychophysiological source traits in a normal individual. *Psychometrika*

Thurstone, L. L. *Multiple-factor Analysis*

Founding of British Journal of Mathematical and Statistical Psychology, by Cyril Burt and Godfrey Thomson

First commercial computer (UNIVAC)

Cattell, R. B. The three basic factor-analytic research designs - their interrelations and derivatives. *Psychological Bulletin*

Green, B. F. The orthogonal approximation of an oblique structure in factor analysis. *Psychometrika*

Cattell, R. B. *Factor Analysis*

L. L. Thurstone moves to University of North Carolina and establishes Psychometric Laboratory

Carroll, J. B. An analytic solution for approximating simple structure in factor analysis. *Psychometrika*

Guttman, L. Image theory for the structure of quantitative variates. *Psychometrika*

Saunders, D. R. An analytic method for rotation to orthogonal simple structure. *ETS Research Bulletin 53-10*

Stephenson, W. *The Study of Behavior: Q-Technique and Its Methodology*

Uppsala meeting in Sweden on FA participants included Gösta Ekman, Herman Wald, Maurice Bartlett, D. N. Lawley, Sten Henrysson, Georg Rasch, Peter Whittle

Harman, H. H. *Modern Factor Analysis*

Cattell, R. B. Theory of fluid and crystallized intelligence: a critical experiment. *Journal of Educational Psychology*

Anderson, T. W. The use of factor analysis in the statistical analysis of multiple time series. *Psychometrika*

Lawley, D. N., & Maxwell, A. E. *Factor Analysis as a Statistical Method*

Meredith, W. Notes on factorial invariance. *Psychometrika*

Horn, J. L. A rationale and technique for estimating the number of factors in factor analysis. *Psychometrika*

Kaiser, H. F., & Caffrey, J. Alpha factor analysis. *Psychometrika*

Horst, P. *Factor Analysis of Data Matrices*

Bock, R. D., & Bargmann, R. E. Analysis of covariance structures. *Psychometrika*

Cattell, R. B. The scree test for the number of factors. *Multivariate Behavioral Research*

Jennrich, R. I., & Sampson, P. F. Rotation for simple loadings. *Psychometrika*

Meredith, W., & Tisak, J. Tuckerizing curves and surfaces: a generalized PARAFAC problem. *Psychometrika*

Tucker, L. R. Some mathematical notes on three-mode factor analysis. *Psychometrika*

Founding of SMEP by R. B. Cattell and colleagues; organizational meeting at University of Illinois

Browne, M. W. On oblique procrustes rotation. *Psychometrika*

Jöreskog, K. G. Some contributions to maximum likelihood factor analysis. *Psychometrika*

McDonald, R. P. Nonlinear Factor Analysis. *Psychometric Monograph*

Lazarsfeld, P. F., & Henry, N. W. *Latent Structure Analysis*

Humphreys, L. G., & Igen, D. R. Note on a criterion for the number of common factors. *Educational and Psychological Measurement*

Jennrich, R. I., & Robinson, S. M. A Newton-Raphson algorithm for maximum likelihood factor analysis. *Psychometrika*

Jöreskog, K. G. A general approach to confirmatory maximum likelihood factor analysis. *Psychometrika*

Tucker, L. R. Koopman, R. F., & Linn, R. L. Evaluation of factor analytic research procedures by means of simulated correlation matrices. *Psychometrika*

Crawford, C. B., & Ferguson, G. A. A general rotation criterion and its use in orthogonal rotation. *Psychometrika*

Jöreskog, K. G. A general method for the analysis of covariance structures. *Biometrika*

IBM introduces the PC

Apple Computer introduces the Macintosh computer

Browne, M. W. Asymptotically distribution-free methods for the analysis of covariance structures. *British Journal of Mathematical and Statistical Psychology*

McArdle, J. J., & McDonald, R. P. Some algebraic properties of the reticular action model for moment structures. *British Journal of Mathematical and Statistical Psychology*

Steiger, J. H., Shapiro, A., & Browne, M. W. On the multivariate asymptotic distribution of sequential chi-square statistics. *Psychometrika*

McDonald, R. P. *Factor Analysis and Related Methods*

Takane, Y., & de Leeuw, J. On the relationship between item response theory and factor analysis of discretized variables. *Psychometrika*

Bartholomew, D. J., & Knott, M. *Latent Variable Models and Factor Analysis*

Anderson, T. W., & Amemiya, Y. The asymptotic normal distribution of estimators in factor analysis under general conditions. *Annals of Statistics*

Bock, R. D., Gibbons, R., & Muraki, E. Full-information item factor analysis. *Psychological Measurement*

Bollen, K. A. *Structural Equations with Latent Variables*

Meredith, W., & Tisak, J. Latent curve analysis. *Psychometrika*

MacCallum, R. C., & Tucker, L. R. Representing sources of error in the common factor model: Implications for theory and practice. *Psychological Bulletin*

The internet is created

Carroll, J. B. *Human Cognitive Abilities: A Survey of Factor-analytic Studies*

Meredith, W. Measurement invariance, factor analysis, and factor invariance. *Psychometrika*

Browne, M. W., An overview of analytic rotation in exploratory factor analysis. *Multivariate Behavioral Research*

Jöreskog, K. G., & Moustaki, I. Factor analysis of ordinal variables: A comparison of three approaches. *Multivariate Behavioral Research*

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10 Key number pad is introduced

Thomson, G. H. General versus group factors in mental activities. *Psychological Review*

Horst, P. A non-graphical method for transforming an arbitrary factor matrix into a simple structure factor matrix. *Psychometrika*

Burt, C. *The Factors of the Mind: An Introduction to Factor Analysis in Psychology*

Holzinger, K. J., & Harman, H. H. *Factor Analysis: a Synthesis of Factorial Methods*

Lawley, D. N. The estimation of factor loadings by the method of maximum likelihood. *Proceedings of the Royal Society of Edinburgh*

Tucker, L. R. The role of correlated factors in factor analysis. *Psychometrika*

Wolfle, D. Factor Analysis to 1940. *Psychometric Monograph*

Mosier, C. I. Determining a simple structure when loadings for certain tests are known. *Psychometrika*

Thomson, G. H. *The Factorial Analysis of Human Ability*

First electronic computer is invented at Iowa State University

Householder, A. S., & Young, G. Matrix approximation and latent roots. *American Mathematics Monthly*

Thurstone, L. L. Primary Mental Abilities. *Psychometric Monograph*

Burt, C. Correlations between persons. *British Journal of Psychology*

Dwyer, P. S. The determination of the factor loadings of a given test from the known factor loadings of other tests. *Psychometrika*

Holzinger, K. J., & Swineford, F. The bi-factor method. *Psychometrika*

Thurstone, L. L. Psychology as a quantitative rational science. *Science*

Eckart, C., & Young, G. The approximation of one matrix by another of lower rank. *Psychometrika*

Roff, M. Some properties of the communality in multiple factor theory. *Psychometrika*

Guilford, J. P. *Psychometric Methods*

September: First professional meeting of Psychometric Society

September 4, L. L. Thurstone's presidential address to Psychometric Society. *Psychology as a Quantitative Rational Science.* (Subsequently published in *Science*)

First mechanical binary computer is introduced

Meetings of Ledyard Tucker's Working Group on Factor Analysis (Regular participants include Ledyard Tucker, Rolf Bargmann, Harry Harman, Paul Horst, Karl Jöreskog, Bill Meredith, Charles Wrigley)

Kaiser, H. F. The varimax criterion for analytic rotation in factor analysis. *Educational and Psychological Measurement*

Lord, F. M. Some relations between Guttman's principal components of scale analysis and other psychometric theory. *Psychometrika*

Rao, C. R. Estimation and tests of significance in factor analysis. *Psychometrika*

Tucker, L. R. An inter-battery method of factor analysis. *Psychometrika*

Tucker, L. R. Determination of parameters of a functional relation by factor analysis. *Psychometrika*

Schmid Jr., & Leiman, J. M. The development of hierarchical factor solutions. *Psychometrika*

FORTRAN becomes commercially available

Anderson, T. W., & Rubin, H. Statistical inference in factor analysis. *Proceedings of the Third Berkeley Symposium for Mathematical Statistics Problems*

Guttman, L. The determinacy of factor score matrices, with implications for five other basic problems of common-factor theory. *British Journal of Statistical Psychology*

Rao, C. R. Estimation and tests of significance in factor analysis. *Psychometrika*

L. L. Thurstone dies at age 68 at summer cabin in Michigan

Ferguson, G. A. The concept of parsimony in factor analysis. *Psychometrika*

Guttman, L. Some necessary conditions for common-factor analysis. *Psychometrika*

Neuhaus, J. O., & Wrigley, C. The quartimax method: An analytic approach to orthogonal simple structure. *British Journal of Statistical Psychology*

Bentler, P. M., & Bonett, D. G. Significance tests and goodness-of-fit in the analysis of covariance structures. *Psychological Bulletin*

Bentler, P. M., & Weeks, D. G. Linear structural equations with latent variables. *Psychometrika*

Steiger, J. H., & Lind, J. C. Statistically-based tests for the number of common factors. *Psychometric Society presentation*

First hand drive for PCs is developed (holding 10MB)

Jöreskog, K. G. Statistical models and methods for analysis of longitudinal data. In K. G. Jöreskog & D. Sörbom, *Advances in Factor Analysis and Structural Equation Models*

Jöreskog, K. G. On the statistical treatment of ordinals. Analysis against crude classification of the observations. *Multivariate Behavioral Research*

Steiger, J. Factor indeterminacy in the 1930's and the 1970's: Some interesting parallel's. *Psychometrika*

Cattell, R. B. *The Scientific Use of Factor Analysis*

Harman, H. H. *Modern Factor Analysis*

Invention of the 5.25-inch floppy

Christoffersson, A. Factor analysis of dichotomized variables. *Psychometrika*

Humphreys, L. G., & Montanelli, R. G. An investigation of the parallel analysis criterion for determining the number of common factors. *Multivariate Behavioral Research*

Jennrich, R. I. Simplified formulae for standard errors in maximum likelihood factor analysis. *British Journal of Mathematical and Statistical Psychology*

McDonald, R. P. The measurement of factor indeterminacy. *Psychometrika*

Gorsuch, R. *Factor Analysis*

Jennrich, R. I. Standard errors for obliquely rotated factor loadings. *Psychometrika*

Jöreskog, K. G. A general method for estimating a linear structural equation system. In A. S. Goldberger & O. D. Duncan (Eds.), *Structural Equation Models for the Social Sciences*

Tucker, L. R. & Lewis, C. A reliability coefficient for maximum likelihood factor analysis. *Psychometrika*

Tucker, L. R. Relations between multidimensional scaling and three-mode factor analysis. *Psychometrika*

Mulaik, S. A. *The Foundations of Factor Analysis*

Jöreskog, K. G. Simultaneous factor analysis in several populations. *Psychometrika*

Schönemann, P. H. The minimum average correlation between equivalent sets of uncorrelated factors. *Psychometrika*

Basilevsky, A. *Statistical Factor Analysis and Related Methods: Theory and Applications*

Cudeck, R., & O'Dell, L. L. Applications of standard error estimates in unrestricted factor analysis: Significance tests for factor loadings and correlations. *Psychological Bulletin*

Legend

Milestone Journal Articles

Major Books and Monographs

Historical Events

Technology Milestones