ED751: Scaling Methods for the Behavioral Sciences

"We must measure what is measurable and make measurable what cannot be measured"

-Galileo

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Office Hours for Fall 2010:
Mondays: 1:00 to 2:30 p.m.
Fridays: 12:30 to 2:00 p.m.
Other times by appointment

Course Syllabus for Fall 2013

This course provides an introduction to the philosophy of measurement and to the methods used in developing scales for measuring attributes of objects and people. The course emphasizes scaling methods used in educational testing and psychological research. Mathematical procedures useful for discovering the structure of multivariate data are also covered. A central focus of the course is on multidimensional scaling (MDS) and its use in evaluating the consistency of data structure across groups and individuals. An important scaling method that is not covered in this course is item response theory, since it is comprehensively covered in EDUC736 and other courses.

In this course, students will learn different perspectives of the science of measurement, and they will learn specific scaling techniques such as Thurstone scaling, Likert scaling, Guttman scaling, and MDS. Cluster analysis methods will also be covered as a form of discrete scaling. Upon successful completion of this course, students will have an increased understanding of measurement scales and their proper uses and they will be able to apply MDS and cluster analysis to a wide variety of educational and psychological research problems.

Textbooks (Monographs)

I will give numerous handouts throughout the semester. Students should purchase the following research monographs, which are available from the UMASS Textbook Annex and Sage publishers (www.sagepub.com).

Aldenderfer, M. S., & Blashfield, R. K. (1984). *Cluster analysis*. Beverley Hills, CA: Sage.
Kruskal, J. B., & Wish, M. (1978). *Multidimensional scaling*. Newbury Park, CA: Sage.
McIver, J. P., & Carmines, E. G. (1981). *Unidimensional scaling*. Newbury Park, CA: Sage.

If you can afford to buy them, I also recommend the following seminal books, which are not in the textbook annex, but can be purchased online at Amazon.com and similar sites:

Arabie, P., Caroll, J. D., & DeSarbo, W. S. (1987). *Three-way scaling and clustering*. Newbury Park, CA: Sage.
Borg, I., & Groenen, P. (1997). *Modern multidimensional scaling: Theory and applications*. New York: Springer-Verlag.
Davison, M. L. (1992). *Multidimensional scaling*. Malabar, FL: Krieger.

Grading:
Your grade in this course is based on attendance/participation (15%), homework assignments (35%), research critique (10%), and final project (40%). The final assignment will involve analysis of data using MDS and writing a report of the results. This project will be discussed in class. Attendance/participation and all assignments are graded on a 0-100 scale. Final grades of 94-100 receive an A, 90-93 receive an A-, 87-89 receive a B+, 81-86 receive a B, 79-80 receive a B-, 77-78 receive a C+, 70-76 receive a C, and below 70 receive an F.

Research Critique: In this assignment you are to select one of the application articles below and address the following questions and topics:

1. What were the objectives of the study? What is the significance of these objectives?
2. Briefly describe the MDS model(s) used. Discuss how the author(s) evaluated data/model fit and interpretation of the stimulus space (and subject space, if applicable).
3. What are the strengths and weaknesses of the study? Do you agree with the author(s)' conclusions? Describe any plausible rival hypotheses and discuss the generalizability of the results.
4. Discuss the implications of this study for future research in this area.

Papers should be typed, 3-6 pages single-spaced, and otherwise conform to APA style (6th ed.).

APPLICATION ARTICLES

D'Agostino, J., Karpinski, A., & Welsh, M. (2011). A method to examine content domain structures. *International Journal of Testing*, *11*(4), 295-307.

Day, S. X., & Rounds, J. (1998). Universality of vocational interest structure among racial and ethnic minorities. *American Psychologist*, 53, 728-736.

Deville, C. W. (1996). An empirical link of content and construct validity evidence. *Applied Psychological Measurement*, 20, 127-139.

Napior, D. (1972) Nonmetric multidimensional techniques for summated ratings. In Shepard, R.N.; Romney, A.K.; and Nerlove S.B. (Eds.), *Multidimensional scaling: Volume 1: Theory* (pp. 157-178). New York: Seminar Press.

Robin, F., Sireci, S.G., & Hambleton, R.K. (2003). Evaluating the equivalence of different language versions of a credentialing exam. International Journal of Testing, 3, 1-20.

Wainer, H., Hurt, S., & Aiken, L. (1976). Rorschach revisited: A new look at an old test. *Consulting and Clinical Psychology*, 44, 390-399.

Academic Honesty Statement: Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent.

Plagiarism policy: It is expected that you will speak with others about course content and even work collaboratively on some class assignments. However, direct copying of someone else=s work is not allowed. Printing out someone else=s computer output, and handing it in as your own work, is also not allowed. Passing off someone else=s work as your own will result in failing this course. According to the University's *Academic Regulations* (www.umass.edu/registrar/media/academicregs.pdf), plagiarism is defined as "knowingly representing the words or ideas of another as one's own work in any academic exercise. This includes submitting without citation, in whole or in part, prewritten term papers of another or the research of another, including but not limited to commercial vendors who sell or distribute such materials." Please see me if you have questions about this policy, or if you have trouble completing any assignments.

Accommodation policy: I strive to provide an equal educational opportunity for all students. If you have a physical, psychological, or learning disability, you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements.

Additional Course References

The literature on scaling and related issues is rich and extensive. I found the following references useful and some are addressed in my lectures. Some are required reading as indicated on the class schedule, and will be distributed in class. Others will be valuable resources if you continue to use scaling techniques after completing the course.

Angoff, W. H. (1984). Scales, norms, and equivalent scores. Princeton, NJ: Educational Testing Service. (Reprint of chapter In R.L. Thorndike (Ed.) *Educational Measurement* (2nd Edition), Washington, DC: American Council on Education, 1971)

Andrich, D., & Styles, I. M. (1998). The structural relationship between attitudes and behavior statements from the unfolding perspective. *Psychological Methods,* 3,, 454-469.

Borg, I., and Lingoes, J.C. (1980). A model and algorithm for multidimensional scaling with external constraints on the distances. *Psychometrika*, 45, 25-38.

Brennan, R. L. (1998). Misconceptions at the intersection of measurement theory and practice. *Educational Measurement: Issues and Practice*, 17 (1), 5-9, 30.

Briggs, D. C. (in press). Measuring growth with vertical scales. *Journal of Educational Measurement*.

Carroll, J. B. (1983). The difficulty of a test and its factor composition revisited. In H. Wainer & S. Messick (Eds.) *Principles of modern psychological measurement: A Festschrift in honor of Frederic H. Lord* (pp. 257-283). Hillsdale, NJ: Lawrence Erlbaum Associates.

Carroll, J.D. and Chang, J.J. (1970). An analysis of individual differences in multidimensional scaling via an n-way generalization of "Eckart-Young" decomposition. *Psychometrika*, 35, 238-319.

Cattell, R. B., & Burdsal, C. A. (1975, April). The radial parcel double factoring design: A solution to the item-vs-parcel controversy. *Multivariate Behavioral Research,* 165-179.

Chen, T., & Davison, M. L. (1996). A multidimensional scaling, paired comparisons approach to assessing unidimensionality in the Rasch model. In G. Engelhard, & M. Wilson (Eds.). *Objective measurement: Theory into Practice* (Volume 3), Norwood, NJ: Ablex.

Clarkson, D B., & Gonzalez, R. (2001). Random effects diagonal metric multidimensional scaling models. *Psychometrika, 66*, 25-43.

Davison, M.L., (1985). Multidimensional scaling versus components analysis of test intercorrelations. *Psychological Bulletin*, 97, 94-105.

Davison, M. L. (1996, August). Multidimensional scaling interest and aptitude profiles: Idiographic dimensions, nomothetic factors. Presidential address delivered to Division 5 of the American Psychological Association, Toronto, Canada.

Davison, M. L., Gasser, M. & Ding, S. (1996). Identifying major profile patterns in a population: An exploratory study. *Psychological Assessment*, 8, 26-31.

Davison, M.L., & Sireci, S.G. (2000). Multidimensional scaling. In H.E.A. Tinsley & S. Brown (Eds.) *Handbook of multivariate statistics and mathematical modeling* (pp. 325-349). Washington, DC: American Psychological Association.

Davison, M.L., & Skay, C.L. (1991). Multidimensional scaling and factor models of test and item responses. *Psychological Bulletin*, 110, 551-556.

Dawes, R.M. (1977). Suppose we measured height with rating scales instead of rulers? *Applied Psychological Measurement*, 1, 267-273.

De Ayala, R. J., & Hertzog, M. A. (1991). The assessment of dimensionality in item response theory. *Multivariate Behavioral Research*, 26,765-792.

Dimitriadou, E., Dolnicar, S., & Weingessel, A. (2002). An examination of indexes for determining the number of clusters in binary data sets. *Psychometrika, 67*, 137-160.

Dong, H. (1985). Chance baselines for INDSCAL's goodness of fit index. *Applied Psychological Measurement*, 9, 27-30.

Dunteman, G. H. (1989). *Principal components analysis*. Newbury Park, CA: Sage.

Edwards, A. L. (1957). *Techniques of attitude scale construction*. NY, NY: Appleton-Century-Crofts.

Egan, K.L., Sireci, S.G., Swaminathan, H., & Sweeney, K. (1998, April). *Effect of item bundling on the assessment of test dimensionality*. Paper presented at the annual meeting of the National Council on Measurement in Education, San Diego, CA.

Engelhard, G. (1984). Thorndike, Thurstone, and Rasch: A comparison of their methods of scaling psychological and educational tests. *Applied Psychological Measurement, 8*, 21-38.

Fitzpatrick, S. J. (1990, April). *Adaptive testing with item difficulty estimates obtained through nonmetric MDS*. Paper presented at the annual meeting of the National Council on Measurement in Education, Boston, MA.

Friedman, H. P., & Rubin, J. (1967). On some invariant criteria for grouping data. *Journal of the American Statistical Association*, 62, 1159-1178.

Frisby, C. L. (1996). The use of multidimensional scaling in the cognitive mapping of cultural difference judgments. *School Psychology Review*, 25, 77-93.

Gable, R. K., & Wolf, M. B. (1993). *Instrument development in the affective domain* (second edition). Boston, MA: Kluwer.

Gaito, J. (1980). Measurement scales and statistics: Resurgence of an old misconception. *Psychological Bulletin*, 87, 564-567.

Gardner, P.L. (1975). Scales and statistics. *Review of Educational Research*, 45, 43-57.

Gierl, M. J., Leighton, J. P., & Hunka, S. M. (2000). Exploring the logic of Tatsuoka's rule space model for test development and analysis: An NCME instructional module. *Educational Measurement: Issues and Practice, 19(3)*, 34-44.

Green, S.B. (1983). Identifiability of spurious factors with linear factor analysis with binary items. *Applied Psychological Measurement*, 7, 3-13.

Groenen, P. J. F., & Heiser, W. J. (1996). The tunneling method for global optimization in multidimensional scaling. *Psychometrika*, 61, 529-550.

Guttman, L. L. (1950). The basis for scalogram analysis. In S.A. Stouffer (Ed.), *Measurement and prediction*, (pp. 60-90). Princeton, NJ: Princeton University Press.

Guttman, R., Epstein, E. E. Amir, M., & Guttman, L. (1990). A structural theory of spatial abilities. *Applied Psychological Measurement*, 14, 217-236.

Hambleton, R. K., & Rovenelli, R. J. (1986). Assessing the dimensionality of a set of test items. *Applied Psychological Measurement*, 10, 287-302.

Hambleton, R. K., Swaminathan, H., & Rogers, H. J. (1991). *Fundamentals of item response theory*. Newbury Park, CA: Sage.

Hattie, J. A. (1985). Methodology review: Assessing unidimensionality of a set of test items. *Applied Psychological Measurement*, 9, 139-164.

Hattie, J, Krakowski, K., Rogers, H. J., & Swaminathan, H. (1996). An assessment of Stout's index of essential unidimensionality. *Applied Psychological Measurement*, 20, 1-14.

Heiser, W.J., & Meulman, J. (1983). Constrained multidimensional scaling, including confirmation. *Applied Psychological Measurement*, 7, 381-404.

Horan, C. B. (1969). Multidimensional scaling: Combining observations when individuals have different perceptual structures. *Psychometrika, 34*, 139-165.

Johnson, S.C. (1967). Hierarchical clustering schemes. *Psychometrika*, 32, 241-254.

Kruskal, J.B. (1964a). Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika*, 29, 1-27.

Kruskal, J.B. (1964b). Nonmetric multidimensional scaling: A numerical method. *Psychometrika*, 29, 115-129.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 140, 44-53.

Lord, F. M. (1952). On the statistical treatment of football numbers. *American Psychologist*, 8, 750-751.

MacCallum, R. (1974). Relations between factor analysis and multidimensional scaling. *Psychological Bulletin*, 81, 505-516.

MacCallum, R. (1981). Evaluating goodness of fit in nonmetric multidimensional scaling by ALSCAL. *Applied Psychological Measurement*, 5, 377-382.

Maranell. G.M. (Ed.) (1974). *Scaling: A sourcebook for the behavioral scientist*. Chicago, IL: Aldine.

McGuire, D. P., & Davison, M. L. (1991). Testing group differences in paired comparisons data. *Psychological Bulletin*, 110, 171-182.

Meara, K.P., Robin, F., & Sireci, S.G. (2000). Using multidimensional scaling to assess the dimensionality of dichotomous item data. *Multivariate Behavioral Research*, 35 (2), 229-259.

Messick, S. J. (1956). An empirical evaluation of multidimensional successive intervals. *Psychometrika*, 21, 367-375.

Messick, S. J. (1958). The perception of social attitudes. *Journal of Abnormal and Social Psychology*, 52, 57-66.

Michell, J. (1986). Measurement scales and statistics: A clash of paradigms. *Psychological Bulletin*, 100, 398-407.

Michell, J. (1990). *An introduction to the logic of psychological measurement*. Hillside, NJ: Lawrence Erlbaum.

Milligan, G. W. (1980). An examination of the effect of six types of error perturbation on fifteen clustering algorithms. *Psychometrika*, 45, 325-342.

Milligan, G. W. (1981). A Monte Carlo study of thirty internal criterion measures for cluster analysis. *Psychometrika*, 46, 187-199.

Milligan, G. W. (1996). Clustering validation: Results and implications for applied analyses. In P. Arabie, L.J. Hubert, & G. De Soete (eds.) *Clustering and classification*, River Edge, NJ: World Scientific.

Milligan, G. W., & Cooper, M. C. (1986). A study of the comparability of external criteria for hierarchical cluster analysis. *Multivariate Behavioral Research*, 21, 441-458.

Nunnally, J.C. (1978). *Psychometric theory*. New York: MacGraw-Hill.

Oltman, P.K., Stricker, L.J., and Barrows, T.S. (1990). Analyzing test structure by multidimensional scaling. *Journal of Applied Psychology*, 75, 21-27.

Overall, J. E., & Magee, K. N. (1992). Replication as a rule for determining the number of clusters in hierarchical cluster analysis. *Applied Psychological Measurement*, 16, 119-128.

Padilla, J., Benitez, I., Sireci, S. G., & Flores-Galaz, M. (2012). Evaluating structural equivalence in psychological questionnaires using multidimensional scaling. Cross-Cultural Research, 46, 348-365.

Ramsay, J.O. (1977). Maximum likelihood estimation in multidimensional scaling. *Psychometrika*, 42, 241-266.

Ramsay, J.O. (1981). MULTISCALE. In S.S. Shiffman, M.L. Reynolds, & F.W. Young (Eds.), *Introduction to multidimensional scaling* (pp. 389-405). New York: Academic Press.

Ramsay, J.O. (1982). Some statistical approaches to multidimensional scaling data. *Journal of the Royal Statistical Society*, 145, 285-312.

Ramsay, J.O. (1991). *MULTISCALE-II manual: extended version*. Montreal, Quebec: McGill University.

Rand, W. M. (1971). Objective criteria for the evaluation of clustering methods. *Journal of the American Statistical Association*, 66, 846-850.

Raymond, M. R. (1989). Applications of multidimensional scaling to research in the health professions. *Evaluation & the Health Professions*, 12, 379-408.

Rodgers, J.L. (1985). Statistical tests of group differences in ALSCAL-derived subject weights: Some Monte Carlo results. *Applied Psychological Measurement*, 9, 241-248.

Schiffman, S.S., Reynolds, M.L., & Young, F.W. (1981). *Introduction to multidimensional scaling*. New York: Academic Press.

Schwarz, N. (1999). Self-reports: How the questions shape the answers. *American Psychologist*, 54, 93-105.

Shepard, R.N. (1962). The analysis of proximities: Multidimensional scaling with an unknown distance function. *Psychometrika*, 27, 125-140.

Sireci, S.G. (1998). Gathering and analyzing content validity data. *Educational Assessment*,5, 299-321.

Sireci, S. G. (2001). Standard setting using cluster analysis. In C.J. Cizek (Ed.) *Standard setting: Concepts, methods, and perspectives* (pp. 339-354). Mahwah, NJ: Lawrence Erlbaum.

Sireci, S.G. & Geisinger, K.F. (1992). Analyzing test content using cluster analysis and multidimensional scaling. *Applied Psychological Measurement*, 16, 17-31.

Sireci, S.G., & Geisinger, K.F. (1995). Using subject matter experts to assess content representation: A MDS analysis. *Applied Psychological Measurement*, 19, 241-255.

Sireci, S. G., Harter, J., Yang, Y., & Bhola, D. (2003). Evaluating the equivalence of an employee attitude survey across languages, cultures, and administration formats. International Journal of Testing, 3, 129-150.

Sireci, S.G., Robin, F., & Patelis, T. (1999). Using cluster analysis to facilitate standard setting. *Applied Measurement in Education*, 12, 301-325.

Sireci, S.G., Robin, F., Meara, K., Rogers, H.J., & Swaminathan, H. (2000). An external evaluation of the 1996 Grade 8 NAEP Science Framework. In N. Raju, J.W. Pellegrino, M.W. Bertenthal, K.J. Mitchell & L.R. Jones (Eds.) *Grading the nation's report card: Research from the evaluation of NAEP* (pp. 74-100). Washington, D.C.: National Academy Press.

Sireci, S.G., Rogers, H.J., Swaminathan, H., Meara, K.,& Robin, F. (2000). Appraising the dimensionality of the 1996 Grade 8 NAEP Science Assessment Data. In N. Raju, J.W. Pellegrino, M.W. Bertenthal, K.J. Mitchell & L.R. Jones (Eds.) *Grading the nation's report card: Research from the evaluation of NAEP* (pp. 101-122). Washington, D.C.: National Academy Press.

Sireci, S. G., & Wells. C. S. (2010). Evaluating the comparability of English and Spanish video accommodations for English language learners. In P. Winter (Ed.), *Evaluating the comparability of scores from achievement test variations* (pp. 33-68). Washington, DC: Council of Chief State School Officers.

Sokal, R. and Michener, C.D. (1958). A statistical method for evaluating systematic relationships. *University of Kansas Scientific Bulletin*, 38, 1409-1438.

Spector, P.E., (1992). *Summated rating scale construction*. Newbury Park, CA: Sage.

Spence, I. (1982). Incomplete experimental designs for multidimensional scaling. In R.G. Goledge & J.N. Rayner (Eds), *Proximity and preference: problems in the multidimensional analysis of large data sets*. Minneapolis: University of Minnesota Press.

Spence, I. (1983). Monte Carlo simulation studies. *Applied Psychological Measurement*, 7, 405-426.

Steinley, D. (2004). Properties of the Hubert-Arabie adjusted Rand index. *Psychological Methods*, 9, 386-396.

Stevens, S.S. (1946). On the theory of scales of measurement. *Science*, 103, 677-680.

Stevens, S.S. (1959). Measurement. In C.W. Churchman (Ed.). *Measurement: Definitions and theories* (pp. 18-36), New York: John Wiley & Sons.

Stout, W. F. (1987). A nonparametric approach for assessing latent trait unidimensionality. *Psychometrika*, 52, 589-617.

Takane, Y., Young, F.W., and de Leeuw, J. (1977). Nonmetric individual differences multidimensional scaling: An alternating least squares method with optimal scaling features. *Psychometrika*, 42, 7-67.

Thurstone, L. L. (1925). A method of scaling psychological and educational tests. *Journal of Educational Psychology*, 16, 433-451.

Thurstone, L.L. (1927a). Psychophysical analysis. *American Journal of Psychology*, 38, 368-389.

Thurstone, L.L. (1927b). A law of comparative judgment. *Psychological Review*, 34, 273-286.

Torgerson, W.S. (1958). *Theory and methods of scaling*. New York: Wiley.

Tonidandel, S. & Overall, J. E. (2004). Determining the number of clusters by sampling with replacement. *Psychological Methods, 9*, 238-249.

Townsend, J.T., & Ashby, F.G. (1984). Measurement scales and statistics: The misconception misconceived. *Psychological Bulletin*, 96, 394-401.

Williams, V. S. L., Pommerich, M., & Thissen, D. (1998). A comparison of developmental scales based on Thurstone methods and item response theory. *Journal of Educational Measurement, 35*, 93-107.

Yen, W. M., & Burkett, G. R. (1997). Comparison of item response theory and Thurstone methods of vertical scaling. *Journal of Educational Measurement, 34*, 293-313.

Young, F.W. (1981). Quantitative analysis of qualitative data. *Psychometrika*, 46, 357-388.

Young, F.W. (1984). Scaling. *Annual Review of Psychology*, 35, 55-81.

Young, F.W. & Hamer, R.M. (1987). (Eds.). *Multidimensional scaling: History, theory and applications*. Princeton, NJ: Lawrence Erlbaum.

Young, F.W., & Harris, D.F. (1993). Multidimensional scaling. In M.J. Noursis (Ed.). *SPSS for windows: Professional statistics* (computer manual, version 6.0) (pp. 155-222). Chicago, IL: SPSS, Inc.

Young, F.W., Takane, Y., & Lewyckyj, R. (1978). ALSCAL: a nonmetric MDS program with several individual-differences options. *Behavioral Research Methods and Instrumentation*, 10, 451-453.

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TENTATIVE Class Schedule for Fall 2013

Date	Topic	Reading Assignment
9/10	History and Philosophy of Measurement Psychophysical Scaling Measurement Scales and Statistics	Stevens (1946) Lord (1952) Michell (1986)
9/17	The Permissible Statistics Controversy Scaling the Psychological I: Thurstone's Attitude Scaling	Thurstone (1927a, 1927b)
9/24	Scaling the Psychological II: Likert Scaling, Guttman Scaling	Likert (1932) Guttman (1950)
10/1	Scaling Educational Tests: Thurstone Scaling	Thurstone (1925) Engelhard (1984)
10/8	Introduction to Multidimensional Scaling	Kruskal & Wish (1978)
10/15	NO CLASS—Monday Schedule **RESEARCH CRITIQUES DUE**	See (attached) list of application articles
10/22	Classical MDS	Davison (1992, Ch. 5)
10/29	Evaluating Fit in MDS Replicated MDS	Sireci & Geisinger (1992)
11/5	Weighted Multidimensional Scaling	Davison & Sireci (2000)
11/12	Interpreting MDS Stimulus and Weight Spaces	Young & Harris (1993) MacCallum (1981)
11/19	Discrete Scaling I: Hierarchical Cluster Analysis Discrete Scaling II: Partitioning Methods	Milligan (1996) Aldenderfer & Blashfield, (1984*)
11/26	Evaluating Test Dimensionality and Data Structure	Hattie (1985) Meara, Robin, & Sireci (2000)
12/3	Factor Analysis and MDS: Similarities and Differences	Davison (1985), Davison & Skay (1991)
12/16	FINAL PROJECT DUE (No Class)	

Note: The instructor will provide handouts for all required readings with the exception of the Sage monographs listed as required textbooks.