Program Abstracts/Algorithms

Scoring Options for Recall Tests (SORT), Version 2.0: Updated to include false mem- ory analyses, nominal group creation, and phenomenological measures

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Scoring Options for Recall Tests (SORT) 2.0 was designed to make the entry and analysis of recall test data efficient and easy. SORT 1.0, its predecessor, computed a variety of analyses, including (1) measures of clustering and subjective organization, (2) descriptive measures, and (3) temporal analysis measures. SORT 2.0 includes all of these analyses, as well as a variety of new ones designed to reflect current trends in experimental research. Some of the new features include (1) the creation of nominal groups for comparison in collaborative recall studies, (2) false memory analysis measures using the Deese (1959)/Roediger and McDermott (1995) paradigm (e.g., output position of nonpresented items, item analysis, net false recall), and (3) phenomenological measures (e.g., confidence ratings or remember/know judgments). In addition, SORT 2.0 has an easy Windows interface, extensive error trapping, and on-line help; it allows for quick inspection of means and is fully compatible with projects created with SORT 1.0.

Many experimental paradigms employ one or more recall tests, along with other subsidiary measures (e.g., confidence measures). If analyzed properly, the data sets from such studies can yield important information regarding, among other things, the amount of information recalled, the accuracy of memory reports, the rate of recall, the consistency of recall across tests, and the subjects' subjective responses to the recalled items (e.g., confidence). One potential problem in analyzing the rich data sets from recall studies is the fact that coding and scoring these data by hand can be a very labor-intensive and error-prone process. A good software package can help researchers exploit the data for all the relevant analyses. Elie, Blackwell, and Payne (1996) introduced a DOS program, Scoring Options for Recall Tests (SORT), Version 1.0, to facilitate this process. SORT 1.0 is a BASIC program that facilitates the entry and analysis of data collected from recall tests. The software described in this article (SORT 2.0) is a program designed to accommodate current trends in experimental psychology, as well as to make the interface even easier for researchers to use. The major updates to

SORT 2.0 include nominal group analyses, false memory analyses using the Deese (1959)/Roediger and McDermott (1995; DRM) paradigm and analyses for phenomenological measures. Below is a more detailed description of these updates.

Recently, there has been an increase in research efforts addressing collaborative recall. One finding that has intrigued researchers is that groups of size X recalling together (true groups) do not seem to be able to exceed or, in most cases, even to match the performance of X individuals statistically combined, deleting redundant responses (nominal groups; see, e.g., B. H. Basden, D. R. Basden, Bryner, & Thomas, 1997; Meudell, Hitch, & Boyle, 1995; Meudell, Hitch, & Kirby, 1992; Weldon & Bellinger, 1997). Making the comparison between true groups and nominal groups, however, requires a large amount of effort (e.g., the recall protocols of individuals must be combined to form the nominal groups). This fact may deter some researchers from doing research involving nominal group comparisons.

To address this, one of the new features of SORT 2.0 is the ability to create nominal groups. The program allows the researcher to enter all the individual data; it then can create nominal groups. The researcher can then decide which individuals form the groups, or SORT 2.0 can randomize which individuals form the nominal groups. This analysis has saved an enormous amount of time analyzing this type of data in our laboratory.

Another rapidly growing area of research is that on false memories (Payne, Elie, Blackwell, & Neuschatz, 1996; Roediger & McDermott, 1995). A popular way to examine false memories has been to use the DRM paradigm. In this paradigm, lists of items are presented that are all related to a critical item that is not presented. A consistent finding is that subjects will recall the nonpresented word as often as the presented words (e.g., Payne et al., 1996; Roediger & McDermott, 1995). SORT 2.0 allows for the entry and evaluation of these nonpresented items. In addition to basic descriptive statistics (e.g., net recall, item gains, item losses, etc.), SORT 2.0 provides specialized analyses for the critical nonpresented items. These specialized analyses include the average output position of the nonpresented items within their list and the frequency with which each nonpresented item is recalled.

Another area into which SORT 2.0 has extended is the phenomenology of items recalled. Often, after items have been recalled, researchers are interested in the subjective experience associated with the recall of those items (e.g., Lampinen, Neuschatz, & Payne, 1997; Payne et al., 1996; Read, 1996). Phenomenology can be measured in several ways—for example, with remember/know judgments (Rajaram, 1993; Tulving, 1985) or con-

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fidence ratings (Payne et al., 1996; Roediger & McDermott, 1995). Regardless of what measure is used, there is valuable information that can be drawn from ratings. SORT 2.0 provides for easy entry of rating data and will provide averages of these ratings, how they change across tests, and the number of items rated above, below, or at the median rating value.

In general, SORT 2.0 is considerably more advanced than its predecessor. Not only is functionality increased, but it also has an easy Windows interface that can make entry easy for laboratory assistants. We have had great success with the program in our laboratory, and regardless of what analyses are needed, SORT 2.0 drastically reduces entry and analysis time, as well as the number of errors committed.

Overview of the Software

SORT, Version 2.0, provides a flexible method for scoring data from almost any type of single or multiple recall testing study. SORT 2.0 was written with Microsoft Visual Basic but could be installed and run on any machine running the Windows 95 operating system. SORT 2.0 can score data from both categorized and uncategorized lists, including categorized lists that employ the DRM procedure for examining false memories. SORT 2.0 allows a user-defined number of tests and will accept rating scores

for items on any number of tests. If the data are collected so that the time intervals during which each item is recalled are available (e.g., the first, second, . . . , minute of the test period; see Payne, 1986, for an illustration of a procedure that produces these data), SORT 2.0 will score the data in terms of the number of items recalled within each time interval across each test, as well as give the cumulative recall across the entire time of testing (see Payne, 1986; Roediger, Payne, Gillespie, & Lean, 1982).

SORT 2.0 will also allow for the creation of nominal groups and the generation of a serial position curve. The data are also scored for (1) intertest forgetting and item recovery (or reminiscence), (2) pair frequency (see Sternberg & Tulving, 1977), (3) the Adjusted Ratio of Clustering (ARC) score, a measure of the degree of subjective organization (see Roenker, Thompson, & Brown, 1971), and (4) the mean number of items recalled per category and the number of categories represented (when categorized lists are used). These measures can be calculated within SORT 2.0 and allow the user to examine the means. They can also be exported for analysis in standard statistical packages. Table 1 presents a description of the dependent measures that are computed by the program. Some of the dependent measures listed in Table 1 can apply to several different conditions. For instance, *Net Recall* can be broken down by minute, can be generated

Table 1
List of All the Dependent Measures Available in SORT 2.0

Dependent Measure	Description
General	
Net recall	The total number of items recalled on test N .
Items gained	The number of items recalled on test N but not on test $N - 1$.
Items lost	The number of items recalled on test $N - 1$ but not on test N .
Cumulative recall	A minute by minute cumulative count across all tests of new items recalled by the subject.
Serial position	The likelihood of each study item being recalled, based on serial position for each test.
Bidirectional intertrial repetition or pair frequency	A measure of the frequency of items being recalled in pairs across tests, regardless of order. The higher the score, the greater the number of pairs of words recalled together from test N to test $N + 1$.
Categorized	
Adjusted Ratio of Clustering score	A measure of organization in the recall of categorized lists with a range from +1.0 to -1.0. A score of 1 represents a perfect recall organization, a score of 0 represents a random recall organization, and a score of -1 represents a systematically random ordering on test N .
Categories represented	The number of categories represented by at least one member on test N .
Items per category	The average number of items recalled from each category, with at least one item recalled on test N .
Ratings	
Rating average	The average rating given to items recalled on test N .
Rated above/below/at median	The number of items that were given a rating that was above the median rating value.
Gains above/ below/at median	The number of items recalled on test N but not on test $N - 1$ that were also given a rating above the median rating value.
False Memory	
Average prior associates	The average number of associates that were recalled prior to the recall of a critical nonpresented item.
Average post associates	The average number of associates that followed the recall of a critical nonpresented item.
Item analysis	Specifically what critical nonpresented items were recalled.

for nominal group analyses, and can apply to false items. Table 2 presents a list of the dependent measures and under what conditions they will be available.

SORT 2.0 was explicitly designed to make it easy for inexperienced researchers (e.g., laboratory research assistants) to use the program with little or no instruction. There is a complete set of on-line instructions available to the user, however, and it is recommended that all the information in the table of contents be read before the program is used. There are provisions for creating backup copies of individual subject data files (described below), and there is extensive error trapping designed to prevent the researcher from writing over a previously entered data set. Our research assistants have been using the software for several semesters and have found it to be easy to learn.

Steps in Using SORT 2.0

To use the program, subjects' recall tests are first coded according to a straightforward scheme. If the items are from a randomized list (i.e., not a categorized list), each item from the study list is assigned a number from 1 to N , the total number of items in the study list. If the items are from a categorized list, the items need to be numbered so that all of the items from one category are numbered 1 to C (the number of items in each category; each category must contain an equivalent number of ex-

emplars in the study list), the next category $C + 1$ to $2C$, and so forth. There is an example of coded data in the on-line help available within the program. These codes are the data that are used to compute the measures listed in Table 1. If you are coding data from an experiment that used the DRM paradigm, simply code the nonpresented item as the last item in each category.

After the items have been coded, these codes are entered into SORT 2.0. If the recall tests were administered so that it is possible to determine consecutive temporal bins (e.g., minutes) during which each item was recalled, these data are also entered along with the item numbers. In addition, if ratings were taken on any test, these are entered along with the other information. Each subject's data are entered for each of the tests administered, and these data are stored in user-defined files. After the data are entered, the user can check the accuracy of the data and make any changes. A master file can be created once the data are entered, and summary descriptive statistics for each subject can be viewed. In addition, means can be calculated within SORT 2.0, collapsed across any combination of independent variable markers. This master file can also be exported for use in any statistical software package that will accept an ASCII file. The software also makes it possible for users to check (and edit, if necessary) previously entered data.

Files Generated

The SORT program generates a number of files for a variety of reasons. Table 3 lists these files and their functions in the program. Generally, the output of SORT 2.0 is generated in *master* files that are comma-delineated ASCII files that can be read into most spreadsheet software (e.g., Microsoft Excel, Lotus123) for inspection and editing, as well as into many statistical packages (e.g., Statistica, SAS, SPSS). There are three types of masters that can be created: a general master (containing all individual subject data), a nominal group master (containing nominal group analyses), or a serial position master (containing the serial position curve for the project).

Conclusion

Given the labor-intensive nature of calculating dependent measures, especially those from repeated testing studies and studies that use nominal groups, researchers might not have the resources to fully exploit the rich set of data obtainable from these procedures. SORT 2.0 gives the researcher the opportunity to calculate a wide variety of relevant dependent measures in only a fraction of the time needed to score these data by hand. In addition, SORT 2.0 creates an organized output easily accessible to the researcher. We have found that the use of this software has greatly reduced the number of hours needed to calculate appropriate dependent measures and has greatly increased the feasibility of extracting a more complete set of dependent variables.

Table 2
List of the Measures That SORT Will Compute

Measure	Studied Items	Minute by Minute	Nominal Groups	False Memory
General				
Net recall	X	X	X	X
Items gained	X	X	X	X
Items lost	X		X	X
Cumulative recall	X	X	X	X
Serial position	X			
Bidirectional intertrial repetition	X			
Categorized				
ARC score	X			
Categories represented	X	X	X	
Items per category	X		X	
Ratings				
Rating average	X		X	X
Rated above/below/at median	X		X	X
Gains above/below/at median	X		X	X
Rated higher/lower/same	X			X
False memory only				
Average prior associates				X
Average post associates				X
Item analysis				X

Note—An X in the appropriate column indicates that the measure applies to that type of analysis. For example, *Net Recall* will apply to Studied Items. If you collected minute by minute data, SORT will present the Net Recall for each minute in each test. If nominal groups are calculated, you will be given Net Recall data for the group (also broken down by minute, if appropriate). Finally, if this is a false memory experiment, you will also have Net Recall for the false memory items. If a measure is broken down minute by minute, it will apply to studied items, nominal groups, and false memory analyses.

Table 3
List of Files and Folders Generated by SORT 2.0

File or Directory	Location or Description
Param	A subdirectory created in a user-defined location. Within this subdirectory, the setup parameters for all projects created with SORT 2.0 will be stored.
Sdata	A subdirectory created in all directories in which the user wishes to save data. This subdirectory is where all individual subject data will be saved.
Unfinished	A subdirectory created for individual subject data that were saved prior to being completely entered and checked for errors. Once all of the unfinished data in this directory are completed, the directory will delete itself.
(Project Title).prm	For each project created in SORT 2.0, a .prm file is created and saved in the Param subdirectory. This file contains all of the parameters specific to this project. Backups of this file are created in directories to which data are being saved.
(Project Abbr.)* Sub#(Subject ID).dat	A file saved to the Sdata subdirectory containing individual subject data for subject (Subject ID).
(Project Abbr.) (Master Type).txt	The output of SORT 2.0. These are comma-delineated ASCII files that contain relevant output for a project. There are three types of masters possible: a general master (individual subject analyses), a combined master (nominal group analyses), and a serial position master.
Temp.txt	This file is saved in the Param directory and contains temporary information on a subject currently being entered. In the event of an unexpected interruption to the program, on startup SORT will access this file and restore the lost data, if desired.

*(Project Abbr.) is a user-defined abbreviation for the project.

Availability

A free copy of an executable version of SORT 2.0 is currently available for download. For the address, contact the second author (dpayne@binghamton.edu). Please title the e-mail "SORT address" for fastest reply. SORT 2.0 is also available on floppy disks from the second author by sending \$10 (covering the cost of reproduction and mailing).

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