ART: A Data Aggregation Program for the Behavioral Sciences

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Abstract

Today, many experiments in the field of behavioral sciences are conducted using a computer. While there is a broad choice of computer programs facilitating the process of conducting experiments as well as programs for statistical analysis there are relatively few programs facilitating the intermediate step of data aggregation. **ART** has been developed in order to fill this gap and to provide a computer program for data aggregation that has a graphical user interface such that aggregation can be done more easily and without any programming. All "rules" that are necessary to extract variables can be seen "at a glance" which helps the user to conduct even complex aggregations with several hundreds of variables and makes aggregation more resistant against errors. **ART** runs with Windows XP, Vista, 7, and 8 and it is free. Copies (executable and source code) are available at `http://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/art.html`.

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1. Introduction

Nowadays, a largely increasing number of experiments in the field of behavioral sciences is planned and conducted with the help of computers. The fast increasing development of computers allows experimental designs that were not possible a few decades ago, concerning the conduction of experiments as well as subsequent data analysis. For example, the exact presentation of almost any stimulus material has become accessible to any researcher. Visual stimuli may be presented exactly to milliseconds, visual and acoustical stimuli can be mixed and synchronized, reaction times can be measured at almost any precision needed. In the area of data analysis complex binomial models have come into fashion as well as sophisticated multivariate designs.

As a side effect of the easy accessibility of advanced experimental designs and methods many experiments are affiliated with huge amounts of data. Since the computer offers easy functions

of protocoling, data protocols often are very extensive containing not only one or two variables but a few dozens or even hundreds of them. This way the researcher has the possibility to try different methods of evaluating data at any time and no valuable information is lost. This sometimes leads to new insights that may turn out to be of more relevance than the initial objective of the investigation.

Before data can be evaluated by statistical or other mathematical software the "raw data" have to be aggregated to a format suitable for further computations. Single protocol files of different participants have to be aggregated to one file, mean values or frequencies of occurrence have to be calculated.

While there exist a sufficient number of approaches in order to facilitate the creation of sequence controls for the conduction of experiments and to conduct statistical analyses of the data, there are relatively few aids in order to facilitate the intermediate task of data aggregation. Spreadsheet programs can be used for simple aggregation tasks like the computation of mean values. Some of them contain even functions for more complex aggregation tasks (e.g., "Pivot tables" in Microsoft Excel). Also some statistics programs like SPSS (IBM Corporation 2013) offer aggregation utilities. However, these programs are mainly designed for evaluating single files. When aggregation from multiple files into one file is needed this is mostly only possible by writing a macro script. A further possibility is to write a computer program for aggregation designed for a special experiment. This can be done with almost every programming language but demands substantial programming skills from the user.

While writing a macro or computer program is relatively easy for experiments with only a few variables it might be very time consuming and – what is worse – error-prone when large data sets are to be aggregated. This task may still be accomplished by an expert who has been conducting behavioral experiments for a long time, but it may be out of depth for a junior researcher like a bachelor or master student. A clear overview of all variables and the rules how to extract them would significantly facilitate the task of aggregation in comparison to writing a computer program or macro in which the code needs to be designed in accordance with the requirements of a particular programming or scripting language.

These were the main reasons that led to the development of **ART** (Lang 2014). The aim was to bridge the gap mentioned above and facilitate the step of data aggregation. **ART** provides a graphical user interface such that no programming skills are necessary in order to accomplish complex aggregation tasks. With the help of the graphical user interface the "rules" that are applied in order to extract variables are listed in a simple and well-readable manner. This way, the user can see "at a glance" which variables have been defined and how they are aggregated instead of being forced to evaluate the code of a programming language. Students can be familiarized with the task of data aggregation with a minimum effort of time and they can be encouraged to try different ways of data analysis.

Another perspective during the development of **ART** has been that any functionality that is implemented is programmed "once and for all". If a researcher writes a computer program dedicated to a special experiment the program is not easily portable to the requirements of other experiments. For example, variables have to be renamed, headers of loops have to be changed, etc. In contrast, a function that is implemented in a general program for data aggregation is available for use in many different experimental contexts. Since **ART** is strictly written in an object-oriented manner it is easy to extent its functionality. Thus, the use of a general program is not only more convenient for the researcher but also reduces the risk of

errors; if a programming error is discovered the error, too, will be removed "once and for all".

ART has been developed not only to aggregate the data of standard experiments but also to aggregate very large data sets. It has been tested to work with protocol files that contain several hundreds of columns and to aggregate data sets that consist of more than 10,000 single protocol files. Especially with large data sets it is important to keep a clear overview over all variables defined. **ART** helps the researcher to keep track of the data by providing multiple "overview areas", providing extended copy-paste functionality, allowing "pre-aggregation" calculations and other useful features.

In the next section the use of ART will be described in detail. A very simple example will be used in order to familiarize the reader with the basic methods used by **ART**. In the sections following on this, a more detailed overview over the functions of **ART** will be given, especially those functions that help the researcher to handle larger data sets.

2. Program handling

2.1. An example experiment

In order to illustrate the process of aggregation with **ART** a fictional experiment is considered in which the relation between attention and reaction times is investigated. In this hypothetical experiment participants' attention is manipulated on three levels. On each level of the attention manipulation the participant is presented 20 stimuli such that a total of 3×20 reaction times is stored in a text file by a computer for each participant. In order to conduct a statistical analysis the 20 reaction times corresponding to an identical level of attention manipulation have to be summarized (e.g., by computing the mean value). Finally, one single file is needed that contains one row for each participant. Each row contains three aggregated reaction times corresponding to the three levels of attention manipulation. When 24 subjects participated in the experiment the file should contain 24 rows with each row having three columns representing the aggregated reaction times of the three levels of attention manipulation.

2.2. The main window of ART

Figure 1 shows the program window of **ART**. The window consists of four main areas.

1. The "protocol view" in the top of the window. One of the to-be-aggregated protocol files is displayed here.

2. The "variable overview" in the middle of the window. An overview of the variables[1] written to the output text file is given here.

3. The "within-subjects view" (bottom left). It shows the "rules" for the extraction of within-subjects variables.

4. The "between-subjects view" (bottom right). It shows the "rules" for the extraction of between-subjects variables.

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[1]For reasons of simplicity, in **ART** one column in the output text file is called "variable" while the exact name would be "one level of a variable".
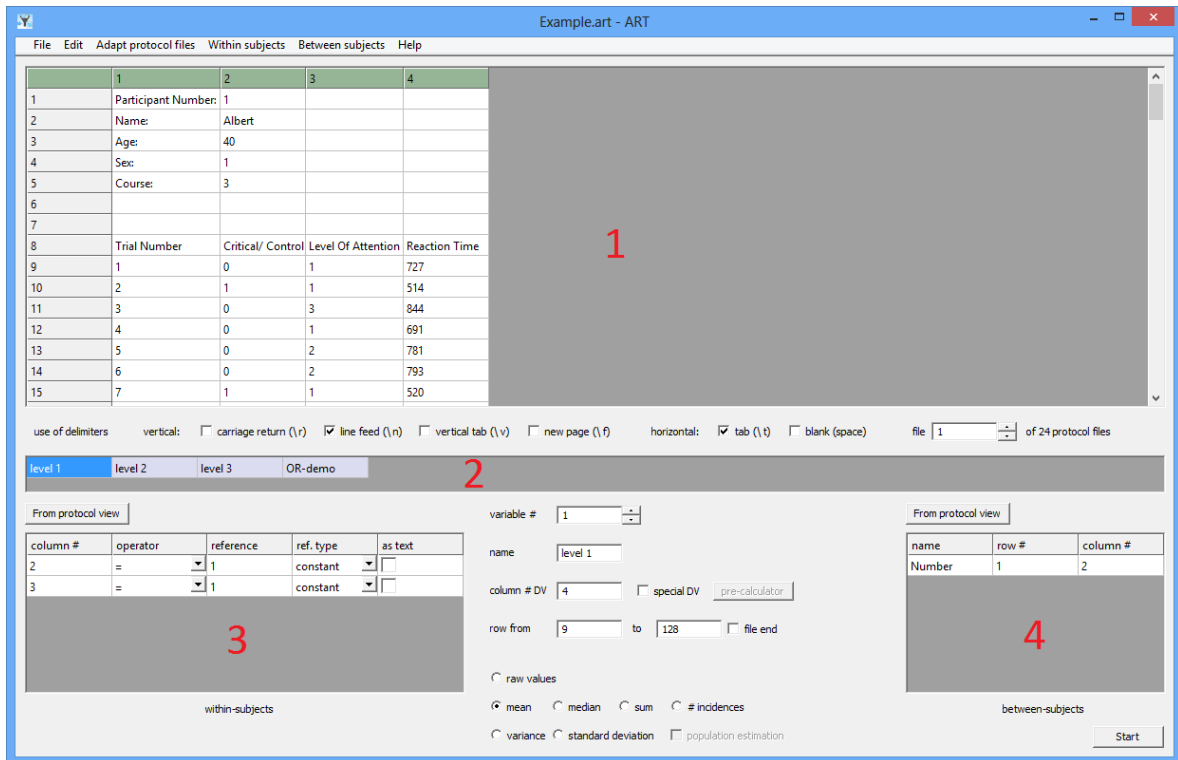
Figure 1: The program window of **ART**. Red numbers designate the four main areas of the window: (1) protocol view, (2) variable overview, (3) within-subjects view, (4) between-subjects view.

2.3. An example session with ART

The example discussed here can be downloaded as a zip-compressed folder at the same download location as the program and from the journal web page. In order to start the example session open the file 'Example.art' by choosing 'File → Open'. After the example has been opened the protocol files have to be selected. This is done with a click on 'File → Select protocol file(s)' and then choosing all protocol files of the subdirectory 'ExampleProtocols'. Multiple files are selected by marking multiple files in the file dialog. **ART** accepts any type of text files. As soon as the file dialog has been closed one of the selected protocol files is displayed in the protocol view (on the top of the **ART** window). Under the protocol view there are several check boxes allowing the selection of the vertical and horizontal delimiters used in the protocol files in order to separate rows and columns. The user can chose 'carriage return (\r)', 'line feed (\n)', 'vertical tab (\v)', and 'new page (\f)' as vertical delimiters; 'tab (\t)' and 'blank (space)' can be selected as horizontal delimiters. The protocol view changes immediately when the selection of delimiters is changed. Thus, if in doubt, the user can try out which choice is appropriate until the protocol file is displayed correctly. On the right of the check boxes the user can toggle between all protocol files previously chosen for aggregation. The first row and the first column of the protocol view contain column numbers and row numbers, respectively such that each "cell" in the file can be identified unambiguously. Further, the first row and the first column of the protocol view can be used to adjust the width and height of each column and each row.

	1	2	3	4
1	Participant Number:	1		
2	Name:	Albert		
3	Age:	40		
4	Sex:	1		
5	Course:	3		
6				
7				
8	Trial Number	Critical/ Control	Level Of Attention	Reaction Time
9	1	0	1	727
10	2	1	1	514
11	3	0	3	844
12	4	0	1	691
13	5	0	2	781
14	6	0	2	793
15	7	1	1	520

Figure 2: Example of a protocol file displayed in the protocol view of **ART**.

In Figure 2 the protocol view of **ART** shows a section of one participant's protocol file of the example experiment. At the beginning of the protocol file some information about the participant is given (name, age, sex, etc.). The header is followed by information about the participant's reactions to the stimuli presented during the experiment. Row 8 contains several labels that denote the kind of information given in a specific column (e.g., the column labeled "Reaction Time" specifies the reaction time in milliseconds for a specific trial). Each row starting from row 9 represents one trial of the experiment.

Four parameters are relevant for this example:

1. The number of the participant ("Participant Number" in the protocol; row 1, column 2; between-subjects).

2. There were critical trials and control trials ("Critical/Control" in the protocol; row 9ff, column 2; within-subjects). The meaning of this differentiation is not of relevance, only insofar as only critical trials should be subject to the following aggregation. Critical trials are labeled with "1", control trials are labeled with "0".

3. The level of the attention manipulation ("Level of Attention" in the protocol; row 9ff, column 3; within-subjects). It can take one of three values: "1", "2", or "3".

4. The "Reaction Time" (row 9ff, column 4; dependent variable).

In order to conduct a statistical evaluation, whether the within-subjects variable "Level of Attention" had a significant effect on the dependent variable "Reaction Time" a text file is needed that contains one row for each participant. Each row has to start with the number of the participant, followed by three entries that contain the reaction times for each of the three

Number	Attention level 1	Attention level 2	Attention level 3
1	530.5	590.5	650.5
2	992.5	983.5	988.5
3	912.3	906.9	909.9
...	...	...	...

Table 1: Desired arrangement of the entries in the resulting text file.

Figure 3: Example of a rule that extracts a between-subjects variable.

levels of attention manipulation. Since each of the three levels of attention manipulation had been applied in 20 identical trials the reaction times for each level of attention have to be aggregated over the identical trials (in this example, mean values are calculated). Table 1 gives an example of how the entries of the resulting text file should be arranged.

As mentioned before, the lower half of the **ART** window contains two viewing areas, the left of which is labeled 'within-subjects' and the right of which is labeled 'between-subjects'. The participant number is a between-subjects variable that can be extracted from each protocol file without further computations. In the between-subjects view of **ART** a name for the variable can be specified as it will be written to the first row of the resulting text file. In this example the variable is labeled "Number". The corresponding entry in the protocol file ("1" in the example protocol file of Figure 1) can be found in row 1, column 2. The whole entry in the between-subjects view can be seen in Figure 3.

As an alternative to typing the row and column number by hand a special form of copy-paste functionality is provided. The user selects the cell of the between-subjects view that contains the name designated for the variable ("Number") and also selects the cell in the protocol view that contains the corresponding information ("1"). When the user clicks onto the button 'From protocol view' above the between-subjects view the correct values for the row and column number are inserted automatically.

An arbitrary number of between-subjects variables may be defined. In order to add a further variable the menu entry 'Between subjects → Insert Variable' is chosen. The between-subjects variables are written into the first columns of the output text file followed by the within-subjects variables.

It is obvious that the within-subject variable "Level of Attention" cannot be extracted in such a direct way as the between-subjects variable. Several "rules" have to be applied in order to extract and aggregate the values needed for the output text file. In the following these rules will be presented together with the way they are specified within **ART**.

As mentioned before, only critical trials are of interest. This means that in the protocol files only rows must be taken into account in which column 2 contains a "1". Thus, in **ART** the first rule is '2 = 1', where '2' is to be entered into the cell with the heading 'column #', '=' is the 'operator', and '1' is the 'reference' (see Figure 4). Alternatively, the rule can be

From protocol view				
column #	operator	reference	ref. type	as text
2	= ▼	1	constant ▼	☐
3	= ▼	1	constant ▼	☐

Figure 4: Both rules for extracting the within-subjects variable as described in the text.

implemented by marking a cell of the rule in the within-subjects view, marking one cell in the protocol view in which the rule is met (i.e., a cell in column 2 which contains "1"), and then clicking on 'From protocol view' above the within-subjects view.

A second rule is needed in order to extract the first level of the attention manipulation. Thus, 'Within subjects → Insert simple rule' is chosen from the menu. In the example protocol file the level of the attention manipulation is listed in column 3. In order to aggregate the first level of the attention manipulation, the rule is '3 = 1'.

By defining the above two rules the rows in the protocol file that contain critical trials ('2 = 1') with the first level of attention manipulation ('3 = 1') are identified unambiguously (Figure 4).

As a next step, the column number of the dependent variable (i.e., the column number of the variable that contains the to-be-aggregated values) has to be specified. In this example the "Reaction Time" is the dependent variable, which is listed in column 4. In the middle of the **ART** window there is an input field labeled 'column # DV'; here the column number of the to-be-aggregated variable ('4') is entered. Since the mean value of various identical trials is to be calculated the radio button 'mean' is chosen. Further, a column title has to be specified that will be shown in the first row of the resulting text file; this is done in the field labeled 'name'. The next step is the specification of the row numbers that will be searched by **ART** in order to extract the rows that contain relevant trials. As can be seen in Figure 2 on page 5 the entries start in row 9 of the protocol file; thus, the entry in the field 'row from' is '9'. The same way the last relevant row is chosen ('to'). In some experiments the total number of trials is not identical in all protocol files such that it is not possible to give a fixed row number in the field 'to'. In this case the user may check the 'file end' check box; this tells **ART** to search each protocol file to its end (independently from the total number of rows).

In order to add columns to the output file for the other levels of attention manipulation (2 and 3) analogous "rule sets" have to be created. For example, in order to create a further column in the output file for attention level 2 'Within subjects → Insert variable' is chosen from the menu. Then, the two rules ('2 = 1' and '3 = 2') are implemented the same way as described above. Please note that **ART** chooses reasonable default values for the input fields in the middle of the window when a new variable is created; the default values of 'column # DV', 'line from', and 'to' as well as the radio button 'mean' are taken from the corresponding entries of the preceding variable since these values do not change in most cases.

Before the resulting output text file can be created the user has to specify its name and storage location. This is done by selecting 'File → Define output file' in the menu bar. The computation is started by a mouse click on the button 'Start'.

When the 'Start' button has been clicked **ART** does the following. After the between-subjects

variables have been written to the resulting text file, the first within-subjects variable is aggregated; each row between the 'row from' and 'to' number (or between the 'row from' number and the last row of the protocol file) is being checked if the two rules specified in the within-subjects view ('2 = 1' and '3 = 1') are met. These two rules are linked in a logical AND manner. Thus, if both rules are met in a row of a protocol file the corresponding entry in the column specified in the field 'column # DV' is taken into account for aggregation and temporarily stored. After all rows of a protocol file have been checked the mean value of the temporarily stored values is calculated and the result is written to the output file. This procedure is repeated with each within-subjects variable. After this, the second, the third etc. protocol file is aggregated the same way.

3. Detailed description of the options in ART

Following this brief introduction into the general handling of **ART**, this section will give a more detailed description of the features implemented in **ART**, especially with respect to features that facilitate the aggregation of larger data sets.

3.1. Adapting the protocol files

Sometimes it may be necessary to slightly modify the protocol files in order to do easier aggregation with **ART**. The menu entry 'Adapt protocol files' offers the possibility to delete unnecessary or problematic rows or columns. In order to delete a row or a column the first cell of the row or column is clicked to mark it. Multiple rows or columns are selected by marking the first row or column to be deleted, pressing the 'control' button and simultaneously marking the last row or column to be deleted. Then the menu entry 'Delete selected row(s)' or 'Delete selected column(s)' may be selected.

In case it is necessary to replace all occurrences of a (sub)string by another (sub)string a global find-and-replace tool is provided. If 'Find and replace' is clicked a dialog appears in which the string to be replaced and the new string can be entered.

The changes made to the protocol files apply to all protocol files chosen for computation as can be seen when toggling through the protocol files. The changes are "non-destructive", this means the changes are applied only internally by **ART**, the protocol files on the hard disk remain unchanged. This way the user can adapt the protocol files in order to evaluate them with **ART** without compromising the possibility to do further computations with other software where the changes could be disturbing.

3.2. Options for variables and rules

The menu that handles the 'Within subjects' variables is divided into two regions. The upper region deals with to-be-created columns in the output text file ("variables"), the lower region deals with the rules of how to extract the variables.

Variables

In the example above 'Insert variable' has been used in order to create a new variable for attention level 2. By choosing 'Insert variable' the new variable is inserted after the variable selected in the variable overview. In this way the user has the possibility to insert

new variables at arbitrary positions between existing variables. In order to keep the number of entries having to be chosen by the user at a minimum, **ART** uses a dynamic system when choosing default values. **ART** assumes that some specifications do not change between different within-subjects variables. Thus, the default values of the elements concerning the dependent variable ('`column # DV`', '`special DV`' and '`pre-calculator`'[2]) as well as '`line from`', '`to`', and the to-be-aggregated value ('`raw values`', '`mean`', '`median`', etc.) are taken from the preceding variable (after which the new variable is inserted). When the user wants to create a variable that is very similar to an existing variable '`Duplicate variable`' may be chosen. This command creates a new variable with all values (including all rules) being set to the corresponding values of the preceding variable. Of course, each value may be changed manually.

The bottom region of the '`Edit`' menu contains a set of entries that offer an extended copy-/paste-functionality for variables, which is especially useful for defining a large number of variables with similar rules.

In order to cut or copy multiple variables the first variable to be cut or copied is chosen in the variable overview by a simple mouse click. Pressing the '`Ctrl`' key and simultaneously clicking the last variable to be cut or copied chooses the last variable. Then, the menu entry '`Cut selected within-variable(s)`' or '`Copy selected within-variable(s)`' is clicked. In order to paste the variables that have just been cut or copied the variable after which the pasting should be done is selected and then, '`Paste within-variable(s)`' is chosen.

In many cases, a set of variables is to be copied and pasted after the *last* existing variable; the '`Edit`' menu contains a "shortcut" for this action. The first and the last variable to be copied are selected as described above, and then, '`Append selected within-variable(s)`' is chosen. This command appends a copy of the selected variables after the end of all variables.

Rules

The bottom region of the '`Within subjects`' menu handles the rules of a variable. A new rule is inserted by choosing '`Insert simple rule`'. When no rule is selected in the within-subjects view the new rule is appended at the end of the rule set, if a rule is selected the new rule is inserted after the selected rule.

As mentioned above, the rules of a variable are usually linked in a logical AND manner. In most cases it may be sufficient to define rules linked in a logical AND manner in order to define the rows of a protocol file that are relevant for aggregating a certain variable. However, in some cases it may be more convenient – or even necessary – to link two or more rules in a logical OR manner. For example, when the absolute value of a number has to be equal to 90 this can be specified easily by two rules that are linked in logical OR manner (<number> = 90 OR <number> = −90). This behavior is achieved by choosing '`Insert OR-rule`'. This command inserts two new rows in the within-subjects view that are displayed in pink color. An OR-rule is not constrained to two rows, but can consist of an arbitrary number of rows; new OR-rows are added by selecting a row within the OR-rule and choosing '`Insert row of same type`'. Simple rules and OR-rules can be used in arbitrary sequence. The logical linking is as follows. All rows within an OR-rule are linked in a logical OR manner while the OR-rule as a whole is linked to the other rules in a logical AND manner. This is

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[2]The functions of '`special DV`' and '`pre-calculator`' are described in the paragraph "The pre-calculator" on page 11.
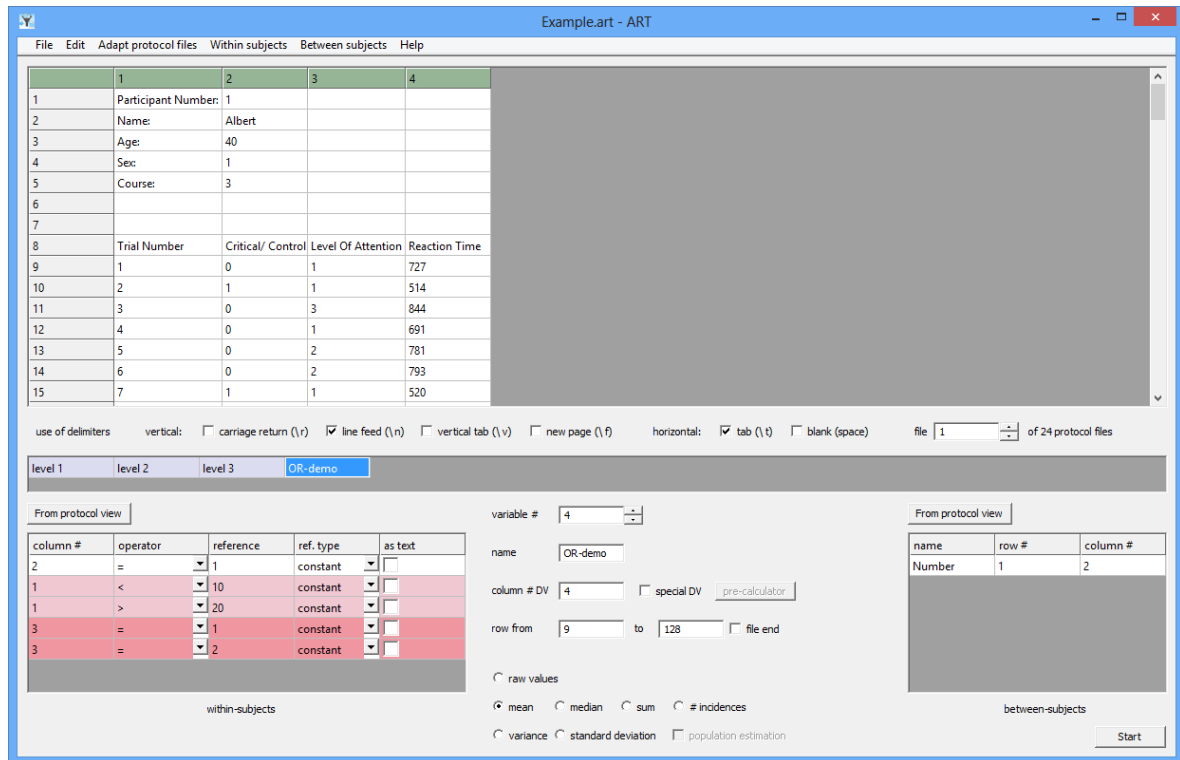
Figure 5: Example of two OR-rules as they are displayed in the **ART** within-subjects view.

even true in the case of one OR-rule directly following another OR-rule, the linking between the OR-rules being in a logical AND manner. In this case the two OR-rules are displayed in slightly different colors.

Figure 5 gives an example of an OR-rule being implemented in **ART**. The first OR-rule ('1 < 10' OR '1 > 20') only includes trials with a number less than 10 OR larger than 20 and thus excludes all trials in the interval between 10 and 20. The second OR-rule ('3 = 1' OR '3 = 2') summarizes trials with the level of attention '1' and '2'.

Within a rule one of eight types of comparison operations ('`operators`') can be chosen within a pop-up menu. These operators are '`less than`' ('`<`'), '`equal or less than`' ('`<=`'), '`equal`' ('`=`'), '`unequal`' ('`<>`'), '`equal or greater than`' ('`>=`'), '`greater than`' ('`>`'), '`equal sign`', and '`unequal sign`'.

The pop-up menu in the column '`ref. type`' has two entries, '`constant`' and '`column #`'. The entry '`constant`' is the default value and has been used in the example above. If '`constant`' is chosen the reference value for the comparison is the value entered in the '`reference`' field. For example, '3 = 5' means that the value listed in column 3 of the protocol file is checked for equality with the *number 5*. If '`column #`' is chosen from the pop-up menu the value entered in the '`reference`' field is interpreted as a column number. In this case, '3 = 5' means that the value listed in column 3 of the protocol file is checked for equality with the value listed in *column 5* of the protocol file.

Usually, the entries of a protocol file consist of numbers. However, some entries of a protocol file may contain text. For example, in a psycho-acoustic experiment one entry in the protocol

files may contain the name of the audio file used for the presentation of the tone. The check box 'as text' on the right side of each rule gives **ART** the instruction to treat the entry in the 'reference' column as a text string instead of a number. The operators 'less/greater than' refer to the alphabetical order of the text strings in this case.

3.3. Options for the dependent variable

ART offers seven measures for the aggregation of the dependent variable which may be chosen separately for each variable (i.e., each column of the output file). The first measure is 'raw values'. If this radio button is checked **ART** will not aggregate the values but write each value of a line corresponding to the rules in the output text file "as is" allowing further computations or aggregation. The measures of aggregation are the computation of the mean value, median, sum, variance, and standard deviation. The radio button '# incidences' deserves special attention. If this button is checked **ART** counts the number of rows between 'row from' and 'to' (or between 'row from' and the end of the file) in which all rules are met. This function is useful for generating histograms.

If 'variance' or 'standard deviation' is chosen two methods of computation are offered. By default, the check box 'population estimation' is chosen as soon as 'variance' or 'standard deviation' is selected. This means that the aggregated trials are treated as a sample of a "population" and the variance or standard deviation is computed as an unbiased estimator of the population variance or population standard deviation according to the formula

$$s^2 = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2 \tag{1}$$

or

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2}. \tag{2}$$

When the check box is not chosen the (uncorrected) sample variance or sample standard deviation is calculated, this means that the denominators in the above formulae are n instead of $n-1$.

The pre-calculator

In most cases the to-be-aggregated variable is listed explicitly in one column of the protocol files (e.g., the reaction time in the study mentioned above). Sometimes it may be useful that prior to aggregation some calculations are conducted. For this reason **ART** offers an extra window called 'pre-calculator'. If pre-calculations are necessary the checkbox 'special DV' may be chosen. A mouse click on the button 'pre-calculator' opens a window in which the user can specify the kind of calculations to be conducted before aggregation. An arbitrary number of column numbers may be entered into the field labeled 'columns'; individual entries are separated by semicolons. As a next step the user chooses one of the four radio buttons 'sum', 'difference', 'mean', or 'median'. The computation of the difference needs special attention. If more than two column numbers are entered **ART** first computes the difference between the first and the second value; from the result the third value is subtracted, etc. The option 'special DV' can be selected or unselected for each variable individually.

4. Regional issues

Most software dedicated to statistical problems takes into account that the decimal separator is a point (".") in some regions and a comma (",") in other regions. **ART** deals with this problem as follows. In order to offer a maximum of flexibility as to protocol files that can be imported **ART** interprets a point as well as a comma as decimal separator when *reading a protocol file*. When *writing to an output text file* **ART** uses the decimal separator as specified by the regional settings of the operating system. Since most statistical software uses the decimal separator as specified in the operating system importing the output text files generated by **ART** should be possible for most programs. From the fact that **ART** interprets a point and a comma as decimal separators when importing files it becomes clear that no thousands separators must be used in the protocol files.

5. Program availability

ART has been developed to run with Windows XP, Windows Vista, Windows 7, and Windows 8. It has also been tested to run with Parallels and CrossOver on Apple Macintosh computers.

ART is a noncommercial program that can be downloaded free of charge. Copies of the executable program as well as the source code are available at http://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/art.html.

Although considerable effort has been put into program development and evaluation, there is no warranty whatsoever. Users are kindly asked to report possible bugs and difficulties in program handling at http://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/art.html.

References

IBM Corporation (2013). *IBM SPSS Statistics 22*. IBM Corporation, Armonk, NY. URL http://www.ibm.com/software/analytics/spss/.

Lang AG (2014). ***ART**: A Data Aggregation Program for the Behavioral Sciences Version 1.0.5*. Heinrich-Heine-Universität – Institut für experimentelle Psychologie, Düsseldorf, Germany. URL http://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/art.html.

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