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An Initial Survey of Fractional Graph and Table Area in Behavioral Journals

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This study examined the fractional graph area (FGA), the proportion of page space used to display statistical graphics, in 11 behavioral journals and places behavior analysis on a continuum with other natural, mathematical, and social science disciplines. The composite FGA of all 11 journals puts behavior analysis within the range of the social sciences, whereas the composite FGA of the most established and preeminent behavioral journals positions behavior analysis within the range of the natural sciences. In addition, fractional table area (FTA), the proportion of page space used to display tables, generally is higher in behavioral journals with lower degrees of FGA, a result that replicates previous research.

Key words: fractional graph area, fractional table area

Statistical graphics, or graphical displays of data, hold an honored position in science. A reason for such veneration and deference emanates from the capacity of statistical graphics for analyzing information, communicating experimental results, and defending, supporting, or refuting claims of knowledge. Cleveland (1984b) surveyed statistical graphic usage in the natural, mathematical, and social sciences. He analyzed journals for fractional graph area (FGA) or the proportion of page space used to display statistical graphics. Cleveland found that journals in the natural sciences had higher FGAs than did journals of the mathematical or social sciences. The results from Cleveland's research shed light on general practices of scientific disciplines when reporting evidence.

Best, Smith, and Stubbs (2001) extended Cleveland's (1984b) research by focusing on psychology and 10 subdisciplines. Best et al. found the rated hardness of psychology journals representative of a subdiscipline correlated very highly with FGA, a positive correlation of .93. For instance, the journals rated as hardest—*Behavioral Neuroscience* and *Journal of Experimental Psychology: Animal Behavior Processes*—had FGAs of .12 and .10, respectively. An FGA of .10 means that for every 100 journal pages 10 of those pages contain statistical graphics. However, statistical graphics turn up in many different places in a journal. Therefore, an FGA of .10 does not literally mean that a journal has 10 pages of statistical graphics and 90 pages of text.

Best et al. (2001) also found that the journals rated as softest—*Journal of Counseling Psychology* and the *Journal of Educational Psychology*—had FGAs of .01 (only 1 page of space devoted to statistical graphics for every 100). In addition, Best et al. found an inverse relation with fractional table area (FTA), the proportion of page space used to display tables, and FGA; journals perceived to be softer had noticeably higher FTAs with corresponding lower FGAs. Those in the softer parts of psychology relied more on tabular displays of data to communicate experimental and applied data.

The emerging body of research that analyzes FGA and FTA (Arsenault, Smith, & Beauchamp, 2006;

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Best et al., 2001; Cleveland, 1984b; Smith, Best, Stubbs, Johnston, & Bastiani-Archibald, 2000) presents a large body of descriptive evidence. The research base demonstrates a reliable method that may aid in the demarcation between hard and soft sciences. Past methods, such as those reported by Cole (1983), have included such tactics as citation review and levels of consensus, examining rejection rates from natural and social science journals, and questionnaire and survey research, among others. Because Cole did not find a method for reliably distinguishing between natural and social sciences, he concluded that no differences exist between sciences "at the top and at the bottom of the hierarchy in either cognitive consensus or the rate at which new ideas are incorporated" (p. 111). Among quantifiable indicators of hardness and softness across scientific disciplines, however, FGA stands out as one of the best measures (Smith et al.). Within scientific disciplines (i.e., natural sciences) that are considered more mature, harder, and with higher degrees of consensus of knowledge, stability, and better codification, researchers have found a greater degree of graphical usage than with the less mature, soft scientific disciples (i.e., social sciences) (Arsenault et al.; Best et al.; Cleveland).

Along the scientific continuum of hard to soft sciences, where does behavior analysis lie? Behavior analysis, long considered a part of psychology, has now developed specialized applications or what some may consider subdisciplines. For example, behavior analysts implement behavioral techniques in education, residential care, with animals, and in industry and organizations. Although a survey of behavior analysts would provide a consensus opinion, analyzing behavior analysis as a field with regard to FGA and FTA could lead to an awareness of different data-communication practices. Unlike psychology and other social sciences, Johnston and Pennypacker (1993) indicate that graphical analysis "has consistently characterized the field of behavior analysis since its inception" (p. 322). Therefore, one might expect minimal differences in the use of data displays across subdisciplines of behavior analysis. Cleveland (1984b) did not include any behavioral journals in his analysis, and Best et al. (2001) measured only one journal, the *Journal of the Experimental Analysis of Behavior* (*JEAB*).

This initial survey of data displays, as expressed by FGA and FTA, determined whether differences occurred across journals that represent subdisciplines of behavior analysis. Specifically, we asked two questions. First, to what extent do behavioral journals dedicate page space to graphs and tables? Second, how does behavior analysis, as its own discipline, compare with other disciplines reported by Cleveland (1984b)?

METHOD

To select representative behavioral journals, we followed criteria described by Critchfield (2002) and Carr and Britton (2003). Both articles identified behavioral journals and focused on either citation or trend analysis. We cross-referenced the journals with a comprehensive set of behavioral journals listed on the Cambridge Center for Behavioral Studies Web site (http://www.behavior.org/links). This resulted in the identification of six journals: *Behavior Modification, Behavior Therapy, Child and Family Therapy, Cognitive and Behavioral Practices, Journal of Applied Behavior Analysis* (*JABA*), and the *Journal of Behavior Therapy and Experimental Psychiatry*. Because most of these six journals targeted different applications of behavior analysis, we chose five additional journals: two that focus on the application of behavior analysis to education—*Education & Treatment of Chil-*

dren and the *Journal of Behavioral Education*—two journals that represent the experimental analysis of behavior—*JEAB* and *Learning & Behavior* (formerly called *Animal Learning & Behavior*)—and one journal relevant to the analysis of verbal behavior—*The Analysis of Verbal Behavior*. The five additional journals had to have a mission statement regarding the analysis or application of behavior-analytic principles and interventions and at least a 10-year record of published behavior-analytic articles.

Cleveland (1984b) defined FGA as the proportion of page space devoted to graphic displays of data. Measurement and calculation of FGA consisted of finding page area (PA) by measuring the length and width of a page, graph area (GA) by measuring the length and width of a graph, and then dividing GA by PA to obtain FGA. Similar to Cleveland's FGA, Best et al. (2001) defined FTA as the proportion of page space devoted to tabular displays of data. Measurement and calculation of FTA followed the same guidelines as FGA. Because Cooper, Heron, and Heward (1987) identified figure legends (the American Psychological Association, 2001, refers to these as figure captions) as a major part of a graphs (see p. 110), we made a slight modification in our measurements of FGA and FTA; that is, we included the figure and table captions as part of the measurable area.

The survey of the 11 behavioral journals began with the random selection of one issue from the volumes published in 2005, 2000, and 1995, yielding a total of 33 issues. We restricted our survey to research articles only. Nonresearch articles included editorial commentary, letters to the editor, book reviews, meeting notes, interviews, obituaries, and specifically titled features such as commentaries, news updates, pharmaceutical reviews and product reviews. If any of the nonresearch articles contained acceptable graphs or tables, however, we included them in the survey.

An acceptable statistical graphic had to have scales or axes and display nominal, ordinal, interval, or ratio data. We excluded pictures, theoretical diagrams, flow charts, and any other figures that did not contain quantitative data. To meet criteria for an acceptable table, the tabular presentation had to have nominal, ordinal, interval, or ratio data, and, at minimum, 75% of the columns contained quantitative data. We used a ruler scaled to 30 cm for measuring length and width of PA, TA, and GA in centimeters squared.

Reliability

A second trained observer assessed 15% of journal issues. We used total agreement to assess reliability of FGA and FTA. Dividing the larger measure (FGA or FTA) by the smaller measure (FGA or FTA) and multiplying by 100% resulted in 100% agreement for FGA and 99.6% agreement for FTA.

RESULTS AND DISCUSSION

The first research question asked to what extent do behavioral journals dedicate page space to graphs and tables. Figure 1 shows the FGA and FTA for all of the behavioral journals sampled on a dot chart (see Cleveland, 1984a, for dot charts). The journals appear along the left side, scaled from highest to lowest FGA. The fraction of space devoted to statistical graphics by the top four journals ranges from .08 for *The Analysis of Verbal Behavior* to .17 for *JEAB*. In other words, a range of 8 to 17 pages of journal space, out of 100, were taken up by statistical graphics. These ratios place the top four behavioral journals on equal footing with journals in the natural sciences (i.e., FGA ranges from .06 in geology to .18 in chemistry). The other seven journals range in FGA

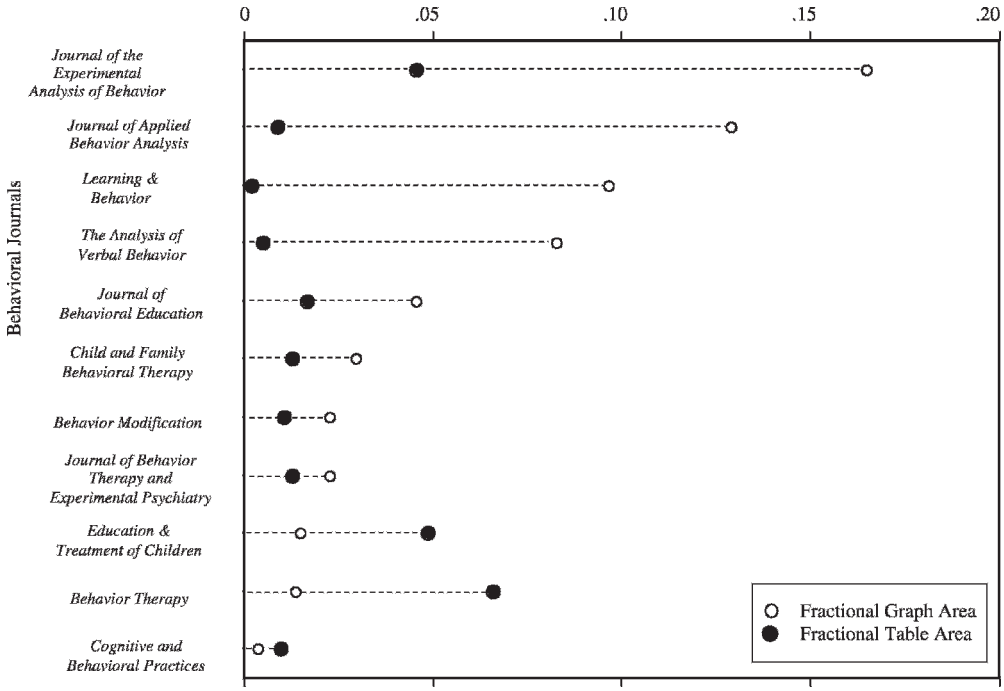

Figure 1. Fractional graph and table area of behavior-analytic journals.

from .004 for *Cognitive and Behavioral Practices* to .04 for *Journal of Behavioral Education*. These seven journals fall either below or within the range of other social science journals (i.e., FGA ranges from .01 in sociology to .056 in psychology).

It appears that even though all of the sampled journals have an explicit mission of applying behavior analysis to specific topical areas, how these journals communicate evidence varies greatly. Behavior-analytic journals yoked with soft sciences like education or counseling mirror the publishing and communication trends of that discipline. Both Cleveland (1984b) and Best et al. (2001) independently demonstrated that education and counseling have very low FGAs, as do behavior-analytic education and counseling journals.

In addition, a general relation emerges among the behavior-analytic journals. Those journals that devote the highest proportion of page space to graphics tend to devote a lower proportion of space to tables, with the exceptions of the journals at the extreme ends in Figure 1—*JEAB* and *Cognitive and Behavioral Practices*. Conversely, journals that allocate more space to tables tend to allocate less space to graphics. To further explore the relation between FGA and FTA, we calculated a correlation for both measures of all 11 journals. The results of the correlation indicate a very weak relation of –.09. However, removing *JEAB* and *Cognitive and Behavioral Practices,* a correlation of –.6 is found, suggesting a moderately strong relation for these journals. *JEAB* and *Cognitive and Behavioral Practices* are atypical when compared to the remaining nine journals. *JEAB* has not only the highest FGA but also the third highest FTA, meaning that *JEAB* has the highest total data display. Contrary to *JEAB*, *Cognitive and Behavioral Practices* has the lowest FGA and the fourth lowest FTA, resulting in the lowest total data display. The inverse relation

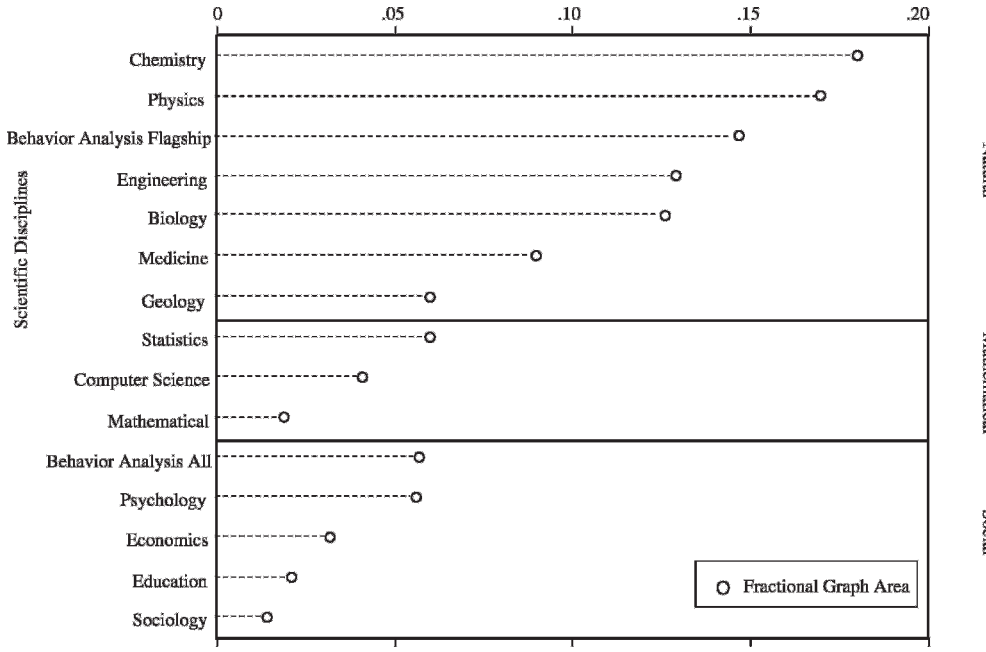

Figure 2. Fractional graph area of scientific disciplines and two representations of behavior analysis.

between FGA and FTA replicates Best et al.'s (2001) finding that researchers in softer subfields of psychology communicate more with tables, whereas researchers in the harder subfields display their results graphically.

The second research question asked how behavior analysis compares to other disciplines of science with respect to FGA. As displayed in Figure 2, the dot chart shows two data points that illustrate the position of behavior analysis in the array of scientific disciplines measured by Cleveland (1984b). The data point labeled "Behavior Analysis All" designates the mean FGA for all 11 behavioral journals. With Cleveland's FGA for the social sciences ranging from .014 (sociology) to .056 (psychology), this data point rests on the upper end, with an FGA of .057. Behavior analysis and psychology have nearly identical FGAs. This finding seems logical considering that both disciplines share a similar subject matter. In addition, Behavior Analysis All represents a composite of subdisciplines such as education, counseling, animal behavior, and social behavior, closely aligned to psychology's subfields. Nevertheless, we recommend caution in interpreting these results because the preliminary analysis may change with a fuller scope of behavioral journals.

The data point "Behavior Analysis Flagship" (Figure 2) corresponds to the average of *JABA* and *JEAB*, the flagship journals for, respectively, applied and basic behavioral research. *JABA* and *JEAB* epitomize behavior analysis, and both have arguably the most respected standing among all behavior journals. The composite FGA of these two journals comes to .147, ranking third behind chemistry and physics. These journals fall in line with Skinner's (1956) emphasis on statistical graphics used in behavior analysis: "We make important aspects of behavior *visible*. Once this has happened, our scientific practice is reduced to simple looking" (p. 229).

Limitations

The present research has two main limitations. First, the journals sampled may not best represent the full scope of behavior analysis or even what some consider strict applications of behavior analysis. Second, our sample included just three issues from each journal, opening the possibly of a different FGA or FTA with additional data. However, this limitation appears to be tempered by Best et al.'s (2001) independent sample of *JEAB*; they measured FGA at .17, and our measure came to an identical .17.

Future Directions

Future directions for expanding this line of research include addressing the two previous limitations, expanding the scope of behavioral journals, and examining FGA and FTA across time. Furthermore, a future study could survey behavior analysts' ratings of the hardness and softness of behavioral journals and then compare those ratings with FGA and FTA. Also, exploring and describing the types of statistical graphics used (e.g., time series, relational graphics) in behavioral journals and examining the quality and effectiveness of such graphics will, to a certain extent, answer how well behavior analysts communicate their experimental findings with statistical graphics.

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