THE CHANGING DATA-BASE OF BEHAVIORAL PSYCHOLOGY: WHERE ARE OUR CURRENT TRENDS TAKING US?

by

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Based on remarks made in an invited symposium to the Association for Behavior Analysis, Dearborn, Michigan, June 19, 1979. Other participants in the symposium were D.M. Baer, A.C. Catania, O.R. Lindsley, J.L. Michael, and B.F. Skinner.

Abstract

Rate of response has traditionally been considered the primary response measure in behavioral psychology research. For over 40 years, operant researchers have preferred response rate to other, less direct, measures in order to investigate response dimensions, such as response strength and probability, and environmental reinforcement contingencies. Despite this historical commitment, however, operant researchers in basic, applied, and clinical settings are replacing rate with other (pre-operant) response measures. For example, measures proposed by Hull, Thorndike, and other learning theorists are challenging the dominance of Skinnerean measurement in current behavioral research. This is particularly dramatic when we consider that Skinner cites rate and the cumulative recorder (device to record changes in rate) as among his major psychological contributions. In addition, the shift in the operant data-base may present major questions regarding the behavioral goals of prediction and control. These trend analyses are intended to stimulate re-evaluation of the importance of rate as a basic behavioral datum.

Figure Legends

Figure 1. Comparison of the number of printed pages in each volume of JEAB, JABA, and BRAT since their inceptions.

Figure 2. Comparison of the number of charts (only those having an an ordinate and abscissa) in each volume of JEAB, JABA, and BRAT since their inceptions.

Figure 3. Comparison of the number of cumulative/time charts in each volume of JEAB, JABA, and BRAT since their inceptions.

Figure 4. Comparison of the number of number/time/time charts in each volume of JEAB, JABA, and BRAT since their inceptions.

Figure 5. Comparison of the number of percent charts (percent of time, percent of responses) in each volume of JEAB, JABA, and BRAT since their inceptions.

Figure 6. Comparison of the number of interval charts (intervals in which the behavior was observed) in each volume of JEAB, JABA, and BRAT since their inceptions.

Figure 7. Comparison of the combined number of duration and latency charts in each volume of JEAB, JABA, and BRAT since their inceptions.

Figure 8. Comparison of the number of subjective rating scale charts in each volume of JEAB, JABA, and BRAT since their inceptions.

The number of psychologists enrolled in Division 25 (Experimental Analysis of Behavior) of the American Psychological Association is nearly forty times greater today than at its inception in 1965. The philosophical differences, which inspired the formation of the new division, are still actively espoused.

For example, behaviorists believe that the most precise and reliable index of human capacity and nature is human behavior. Thus, behavioral psychologists study observable behavior and the environmental variables which control the form and frequency of behavior.

The events that preceded the development of behavioral psychology are documented elsewhere (Boring, 1957). From the early work of Thorndike and Watson, several factions emerged. E.R. Guthrie (1935) and his followers emphasized the contiguous pairing of a stimulus and a response for organisms to learn. Proponents of Hull added rewards to their set of factors believed critical to learning. In addition to observable rewards, Hullians attributed the occurrence of behavior to such intervening variables as habit strength and drive condition (Hull, 1943).

In the late thirties, B.F. Skinner introduced another form of behaviorism, operant conditioning. In his 1976 commentary on the foundations of operant conditioning research, Skinner cited two major dimensions distinguishing it from other behavioral psychologies. They are rate of response and the device to record changes in rate, the cumulative record (Skinner, 1976, emphasis ours). For example, in a 1956 article, Skinner elaborated on the importance of these measurement issues by saying, "[i]n choosing rate of responding as a basic datum and recording this conveniently in a cumulative curve, we make important temporal aspects of behavior visible. Once this has happened, our scientific practice is reduced to simple looking" (Skinner, 1956, p. 117; see also, Skinner, 1956, p. 229; Ferster & Skinner, 1957, pp. 7-8; Ferster, 1978, p. 348).

However, Skinner's 1976 commentary lamented the continuing disuse of the cumulative record ("which told more at a glance than could be described on a page," p. 218). He might also have lamented the abandonment of rate. In the last twenty-three years -- since 1956 -- we have seen major changes in operant psychology's use of Skinnerian measurement.

Historically, Skinner has consistently extolled the virtues of rate as the basic datum of a science of behavior (for a complete review, see Skinner, 1953; 1973, at p. 75; Ferster, et al., 1975). A rate measure tells the number of times a given behavior occurred in a specified length of time. Using rate of responding as the property of behavior under study enables the researcher to look at very subtle changes in behavior over a wide range of conditions. Rate of response is used extensively to measure operant response strength (Hilgard & Marquis, 1940; Keller & Schoenfeld, 1950; Ferster, 1953; Bijou & Baer, 1961; Williams, 1968; Keller, 1969; Catania, 1970). Furthermore, response rate is the most sensitive measure of probability of occurrence and is therefore of central concern to a science of behavior (Skinner, 1938, at p. 58; 1953, at 63; 1969, at p. 77; 1972, at p. 118 and 127; Sidman, 1960, at 398).

Rate or frequency of response was employed with equal vigor in applied settings as operant conditioners moved from the animal laboratory to the human laboratory (Lindsley, 1956; 1972; Skinner, 1972).

This applied emphasis generated substantial interest in behavioral psychology's potential to solve historically controversial issues. Recently, Hilts (1974) and Kazdin (1975) described the diverse applications of behavioral psychology. Accompanying these applications was a flourish of scientific publications. The APA's Search and Retrieval Service reported that the number of journals publishing Applied Behavior Analysis and Behavior Therapy (the applied branches of Skinnerean psychology) articles multiplied by six from 1967 to 1972 (5 years). The annual number of behavior modification (applied behavior analysis and behavior therapy) articles multiplied by 10 during this time (Grudner and Krasner, 1975). Hoon and Lindsley (1974) reported that behavior therapy publications were multiplying by 20 every five years.

It should be important, however, that, despite our recent popularity, behavioral psychologists remain careful quality-controllers. Unfortunately, while the number of behavioral publications multiplies, few have analyzed how our research methods are changing. As one approach, the present study sought to record changes in the frequency of use of the basic rate datum compared to the other (non-Skinnerean) behavioral dependent variables. In this way, the changing influence of the Skinnerean measurement heritage upon current operant conditioning and behavior modification is thus recorded.

The thirteen types of measurement used in three behavioral journals were counted for all issues. The _Journal of Experimental Analysis of Behavior_ (_JEAB_) and the _Journal of Applied Behavior Analysis_ (_JABA_) were chosen because they represent the leading journals in the area. The third publication, _Behavior Research and Therapy_ (_BRAT_), was chosen because it is a frequently read behavioral journal considered less operant than the other two journals.

To obtain counts, we went through each volume page by page. Each chart was placed in one of thirteen categories according to the measures shown on the ordinate and abcissa. As an example of the selection process, refer to the charts in a randomly chosen _JABA_ article. The chart in Copeland, et al. JABA (1974) 7(1) on page 79, is counted in the percent/time category since the numbers on the ordinate represent the percent-of-time three students attended school, and the numbers on the abcissa depict successive weeks. Their chart on page 82 is counted in the number/time category since the number of correct responses is on the ordinate and successive days are on the abcissa.

Counts for each category were totaled each year to yield yearly frequencies. These yearly frequencies were plotted on separate Standard Celeration Charts for each category. Accelerations and decelerations for each category were calculated by the Quarter-Intersect Technique (Pennypaker, Koenig, & Lindsley, 1972; Koenig, 1972) which correlates between .88 (Neufeld & Lindsley, 1977) and .99 (Hnetish, 1976) with least-squares techniques and produces almost identical research conclusions (Koenig, 1972).

Figure 1 pictures the acceleration in the size of the three journals. The number of pages in each volume of BRAT is multiplying by 1.25 (+25%) every five years. JEAB pages are multiplying by 1.35 (+35%) every five years, while pages in JABA, the fastest growing of the three journals, are multiplying by 1.5 (+50%) every five years.

Figure 2 shows the near parallel accelerations in the number of data charts published annually in each journal. Despite the fact that JEAB typically publishes more than three times the number of data charts each year than does JABA and nearly eight times the charts as BRAT, the number of data charts published in each journal is accelerating at nearly the same overall rates (x1.25 every five years).

Changes in the frequency of data charts in JABA and BRAT occurred simultaneously for 8 out of the last 10 years. The probability of this occurring by chance is .11 (1 out of 10) (Siegel, 1956, at 250). The yearly frequency changes in JEAB charts, on the other hand, varied with yearly changes in JABA charts 50% of the time. The probability of this occurring by chance is .623.

By comparing Figures 1 and 2, we can measure changes in the size of the graphic data-base of each journal. The number of pages for each chart in JABA is growing by 25% every five years. In JEAB, pages per chart are growing by 8%; and in BRAT, they are growing by only 4% every five years. From this comparison, we see that JABA is losing its graphic data-base four times faster than JEAB and six times faster than BRAT, but even so, the relative stability of graphic data representation is decelerating in all three behavioral journals.

Because of the historical precedence that cumulative/time charts hold in the development of behavioral research (especially when we consider that this form of measurement and depiction of operant data has enabled such discoveries as deprivation/satiation effects, steady states, and schedules of reinforcement), it is appropriate that we consider first the trend in cumulative/time graphs in these three journals. On the cumulative/time graph, the ordinate represents cumulated number of responses, the abcissa is, of course, some measure of time (in most laboratory research, time has typically been measured in seconds, while in the applied research, time is most often measured in days or weeks), and its slope represents rate or frequency (number per time).

Figure 3 shows the growth of cumulative/time charts appearing in the three journals. As we can see, these charts have been rapidly decelerating by 1.4 in JEAB and 1.7 in BRAT every five years. This is consistent (although not as reactionary) with Skinner's observation that "[e]vidently we have not long to wait for an issue of JEAB without a single cumulative record" (Skinner, 1976, at 218). Moreover, because BRAT has never been exclusively operant-based, we might expect that some degree of data-shift might occur first in this journal. Although cumulative/time charts are accelerating in JABA by 1.2 every five years, their number ranges from 1 to 30 each year and have been decreasing in the last three years.

Perhaps rate charts are taking another form in the literature. With the increase in applied behavioral research, it is reasonable that the daily totaling of frequencies (as was performed automatically by the laboratory-founded cumulative recorder) may not as adequately meet the needs of the applied researcher. He/She may prefer to study rate of response in its absolute daily sense, that is, the number of responses occurring per minute per day. This is known as one form of the number/time/time chart, where rate (number/time, e.g., hair pulls per minute) is placed on the ordinate and a longer time unit (e.g., days) is placed on the abcissa. The slope of this chart is celeration (Pennypacker, et al., 1972) which is the speed at which the frequency changes over some period of time -- the rate of rate change. Just as in measurement used in the science of mechanics, when the rate increases we say that it has accelerated and when it decreases, it has decelerated. The steeper the slope, the faster the frequency is accelerating or decelerating. This rate derivative allows the reader to compare rate changes easily and quickly.

As can be seen in Figure 4, number/time/time charts are accelerating in each of the three journals. They are multiplying by 1.5 (+50%) in JEAB, by 1.8 (+80%) in JABA, and by 2.3 (+130%) in BRAT. The rapid acceleration of these charts in BRAT is further emphasized when we consider that in 1975, there were more than 70 number/time/time charts in JEAB and more than 5 in JABA for every one in BRAT, whereas in 1978, the ratio had divided to 2:1 in JEAB and, for the first time, 1:3 in JABA. Clearly, the field is beginning to use rate-over-time measures more frequently in behavioral research.

Another measure which is gaining popularity in all areas of behavioral research is the percent chart. On this chart, the relationship of two direct measures is transformed into one relative number, e.g., number correct/number incorrect becomes % correct and intervals scored/intervals not scored becomes % intervals scored. However, unless researchers are careful to include information about base performances, percent charts can be misleading. For instance, 40% correct can mean either 4 out of 10 or 6 out of 15 problems answered correctly. While some articles provide readers with the base amount (either 10 or 15), many do not. Comparisons then become relative and abstract and lack direct relevance to actual performances. This is particularly dangerous when we consider that human performances made in free-operant conditions which have no behavior or record ceilings range in frequency from 1 per day to 300 per minute (Lindsley, 1978a).

Figure 5 pictures the acceleration of percent charts in all three journals. In *JEAB*, percent charts are multiplying by 1.6 every 5 years; in *BRAT* by 1.7; and in *JABA* by 2.0 every 5 years.

Comparing Figures 2 and 5 reveals the relative growth of percent charts. The number of percent charts in *JEAB* is multiplying 1.28 times (increasing 28%) *faster* than are total charts. In *BRAT*, percent charts are growing 1.42 times (+42%) faster than total charts. And in *JABA*, percent charts are multiplying 1.67 times (+67%) *faster* than are total charts. Even though the laboratory experimenters appear more concerned with preserving discrete measurement than applied researchers, they are not able to prevent percent from overtaking rate. Table 1, comparing the relative growths of rate and percent charts with total charts, demonstrates that, at best, laboratory experimenters are resisting the slip back to percent more than are applied researchers.

At the current accelerations, all the charts in *JABA* would be percent by the year 1985. All the charts in *JEAB* would be percent by 1995 and all charts in *BRAT* would be percent by the year 1996.

Interval recording, commonly employed in applied behavioral research, often accompanies percent measurement. Interval methods break the total recording period into smaller time units which facilitate reliable observation of applied behavior. Two types of interval records exist -- the "partial interval," in which every response occurring within each brief interval is counted, and the "occurrence-nonoccurrence interval," in which the observer counts only the first response to occur in each brief interval. This latter type of interval recording is used most frequently in applied research and, although offering several procedural advantages to continuous measurement, also masks important aspects of the data.

For example, by counting only one response per interval, all intervals where the behavior occurred at least once are given equal weight. Thus, for a high rate behavior, an interval in which the behavior was emitted 5 times is given the same weight as one in which the behavior was emitted 1 time. Despite the fact that, in theory, the smaller the intervals, the less probable that multiple responses will occur, we are leaving a great deal of behavioral assessment to the laws of probability. Moreover, observations ultimately reach a point where the intervals become so small that we might as well continuously monitor the behavior. Considering the disadvantages of obscuring some data while only grossly monitoring others, the importance given to reliability-through-interval recording should be re-evaluated.

Figure 6 shows the acceleration of interval charts in the three behavioral journals. Similar to percent, interval charts are doubling in JABA (x2) every five years. They are decelerating in BRAT (÷1.65), and, until 1976, had never existed in JEAB. However, interval charts appeared in 1976 and 1977, although they failed to appear in the 1978 JEAB.

Two other behavior measures to appear in the literature are duration and latency. Combined, these measures are said to indicate the strength of responding. Figure 7 shows the acceleration of duration and latency charts in JEAB and BRAT multiplying by 1.5 and 1.8, respectively. These charts are decelerating, however, in JABA by 1.5 every five years. Accelerating acceptance of time measures (as indirect indices of behavior) in JEAB and BRAT may be related to their basic experimental orientations. Time measurement was used by early laboratory experimenters such as Wundt, who in 1880, measured reaction-time as the latency from stimulus to response and Pavlov who, in 1906, measured reflex strength by response latency. Duration and latency were also two of Hull's four indirect behavioral measures (1943).

The preceding five charts represent differing forms of event recording. Even though they range from continuous, all-inclusive behavioral monitoring to relative transformations and time-samples, they are direct accounts of behavior-environment interactions. It was in this tradition that psychology moved from anecdotal analysis to the controlled conditions of the experimental laboratory while becoming the science of behavior (Skinner, 1972). Recently, though, subjective reports have begun to recur in the experimental literature. They have taken the form of subjective rating scales.

Figure 8 pictures the acceleration of rating scale charts in two of the three journals. In BRAT, rating scales have multiplied by 1.2 (+20%) every five years since 1960. This is the same acceleration as with total data charts. Furthermore in JEAB, containing predominantly animal research, rating scales have never existed. This is consistent with the expected difficulties of rating the subject matter or obtaining subject self-reports. It is in JABA, however, where rating scale charts have flourished in recent years. Since 1970, the number of rating scale charts has nearly quadrupled (x3.8) every five years. Thus, while in 1970 there existed in BRAT 30 rating scale charts for every 1 in JABA, by 1977, the ratio had decreased to only 4:1.

Although the nature of the rated data may differ in the two journals -- BRAT emphasizing client self-rating of anxiety, fear, etc. and JABA has recently concentrated on self-rated consumer-satisfaction -- these charts represent a new wave of indirect measurement -- the strength of which may or may not be determined by the success of their ability to predict and control behavior (Watson, 1913).

IMPLICATIONS

The transition from laboratory to applied research has been costly by accelerating the ever-changing behavioral measurement shift. While behavioral scientists eagerly pronounced that rate data was the most sensitive and reliable measure of operant strength and probability (Skinner, 1969, at 76, 81, 214), some have gradually succumbed to the methodological difficulties of recording frequency data in the more complex settings seen in applied research.

However, science is defined according to its scientific methods (Hempel, 1964), and the quality of behavioral science is only as good as its ability to directly measure and predict behavior (Lindsley, 1978b). The type of data collected in any setting should not be determined by its ease of acquisition. The solution to dealing with unusual behavior in complex worlds is not simply to abandon rate measurement in favor of "easier" methods, but to perfect the ease and precision of collecting frequencies in the new settings. Perhaps this can be accomplished through more precise response definitions which allow rate, rather than percent or time dimensions, to be measured. Understandably, this is not an easy task, but, as scientists, we should not fall prey to the laws of response effort (Skinner, 1946).

If we continue to measure frequency of response less and less, while accelerating the pre-operant measures of time and percent, will our research have the same predictive value? The answer to this question will determine how the changing data-base of behavioral psychology is perceived.

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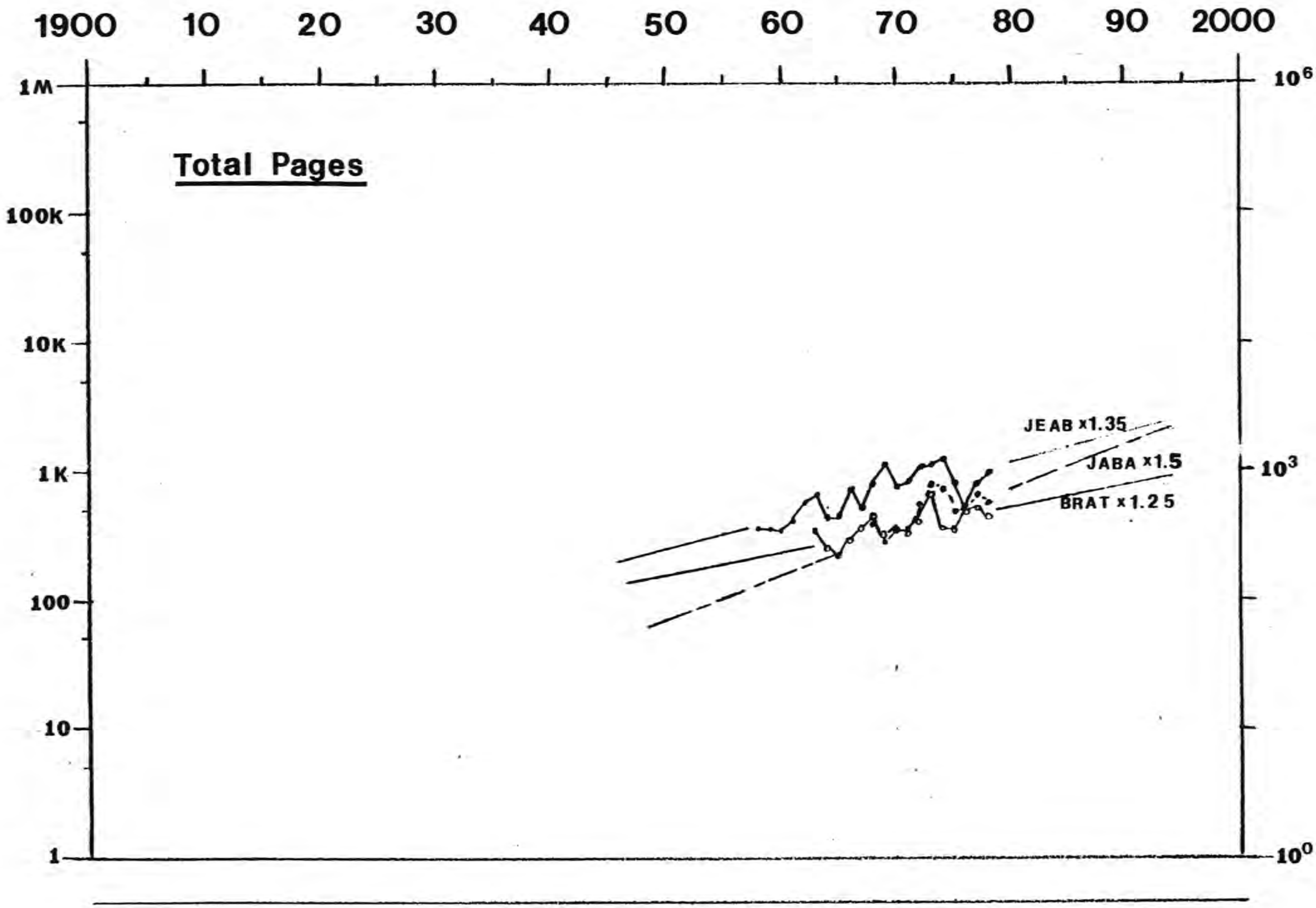

Figure 1

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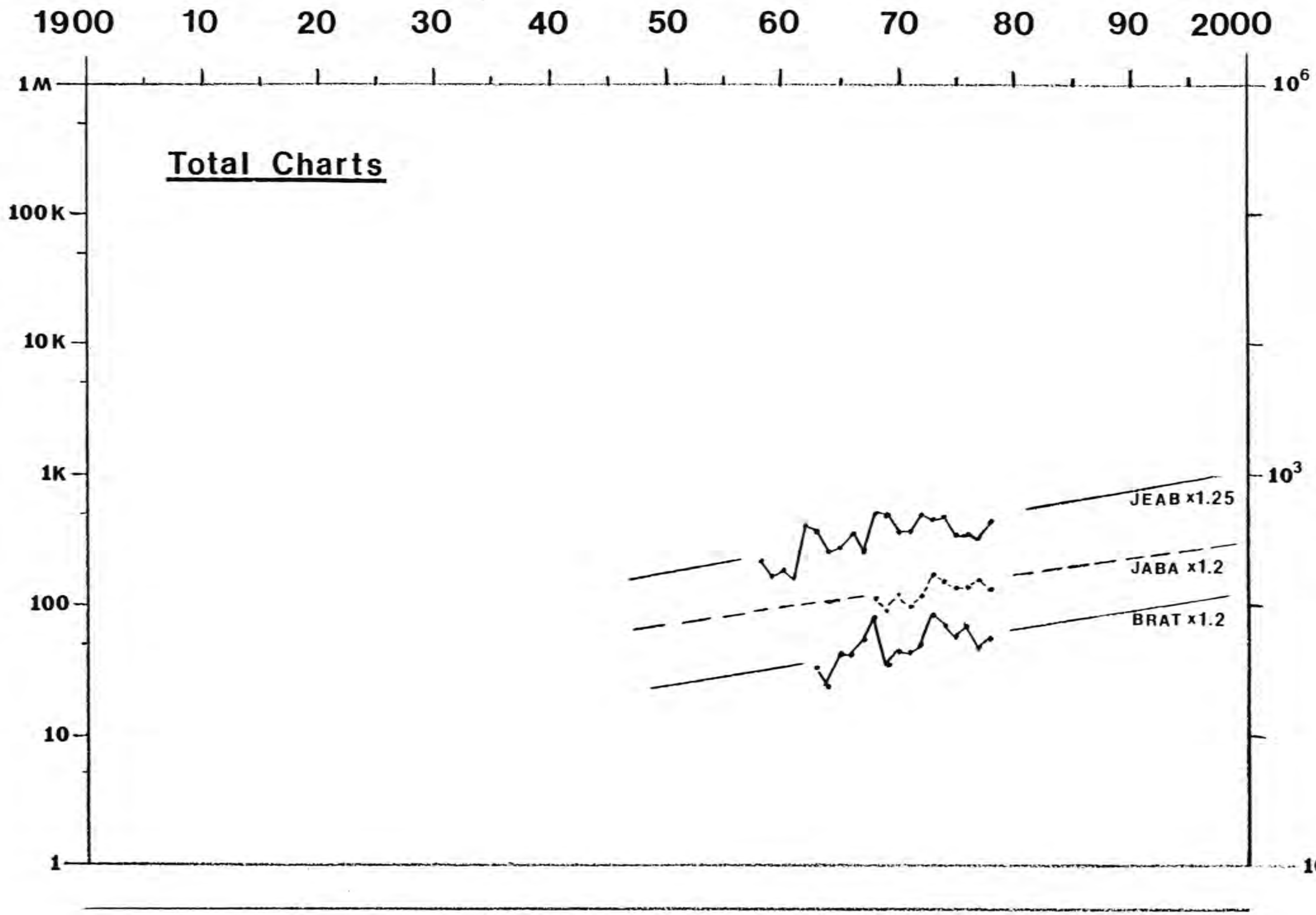

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Figure 2

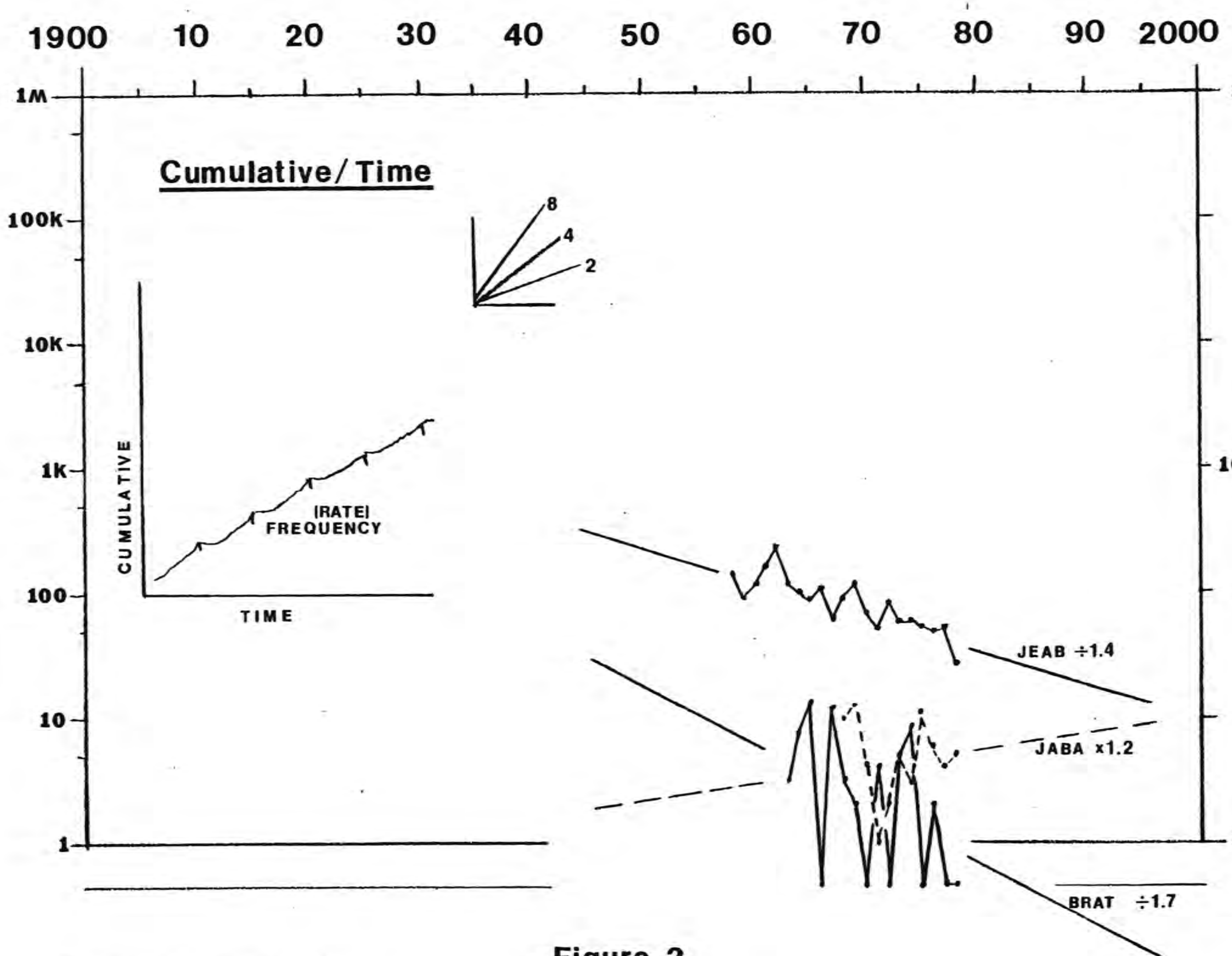

Figure 3

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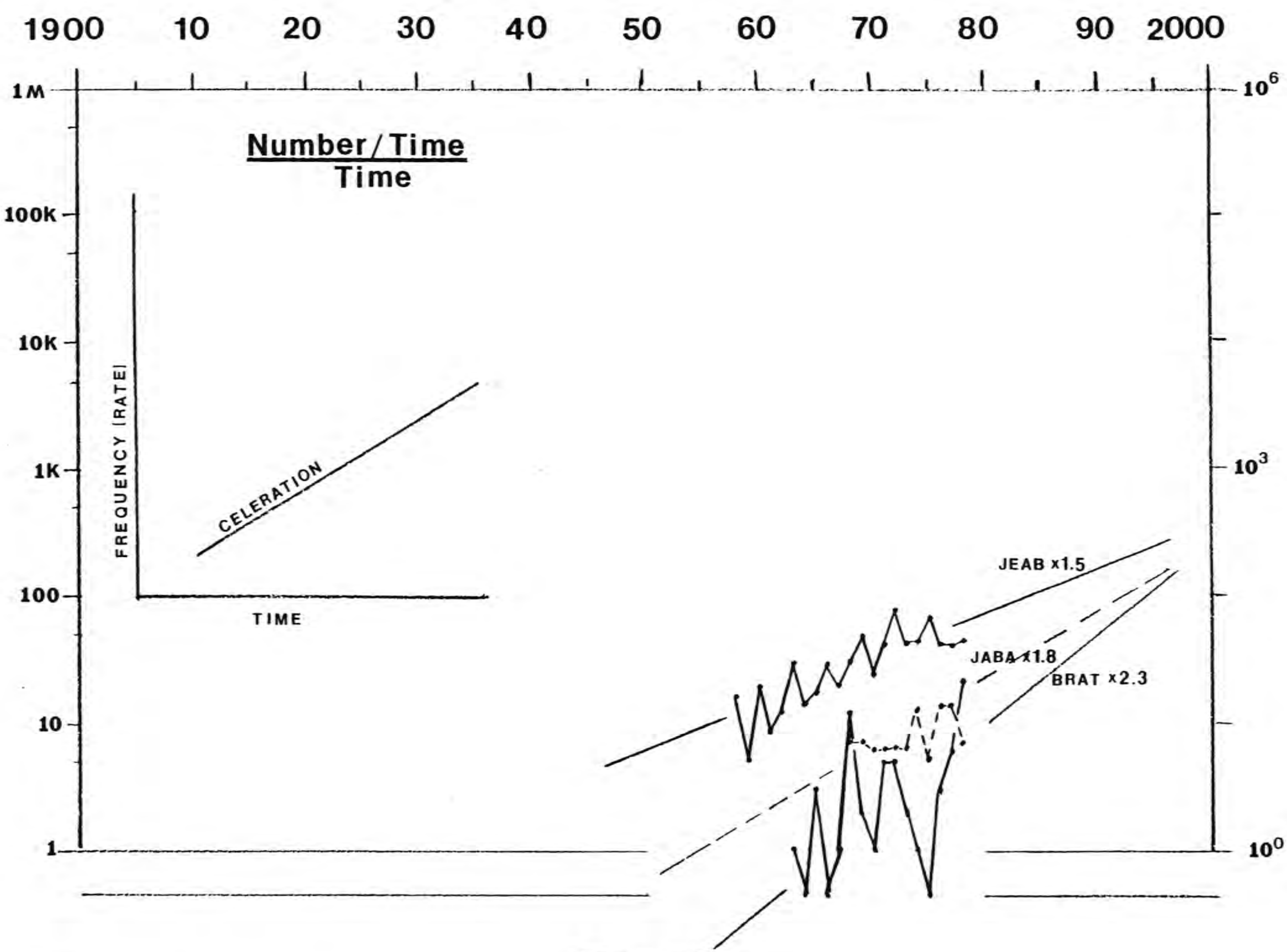

Figure 4

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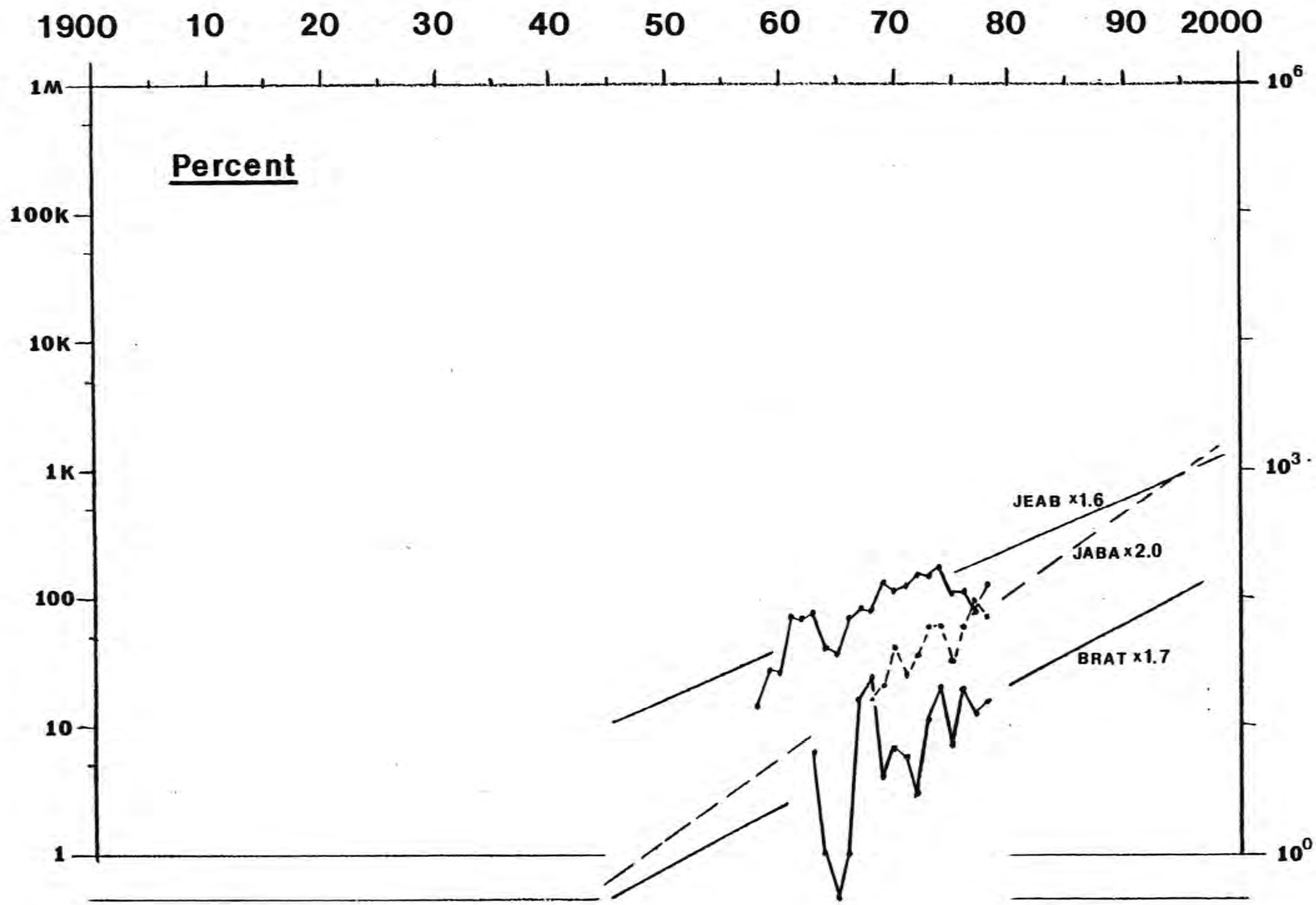

Figure 5

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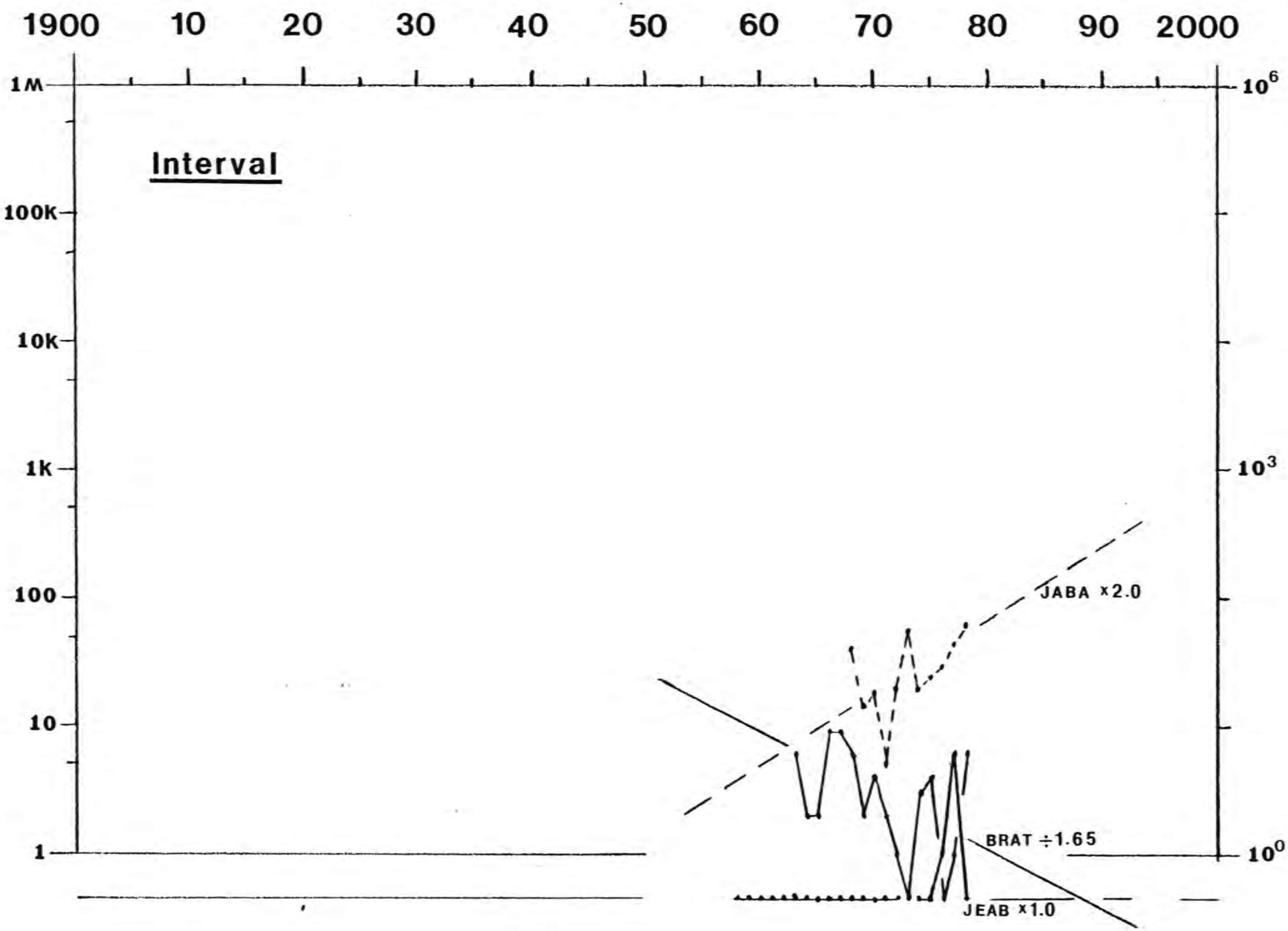

Figure 6

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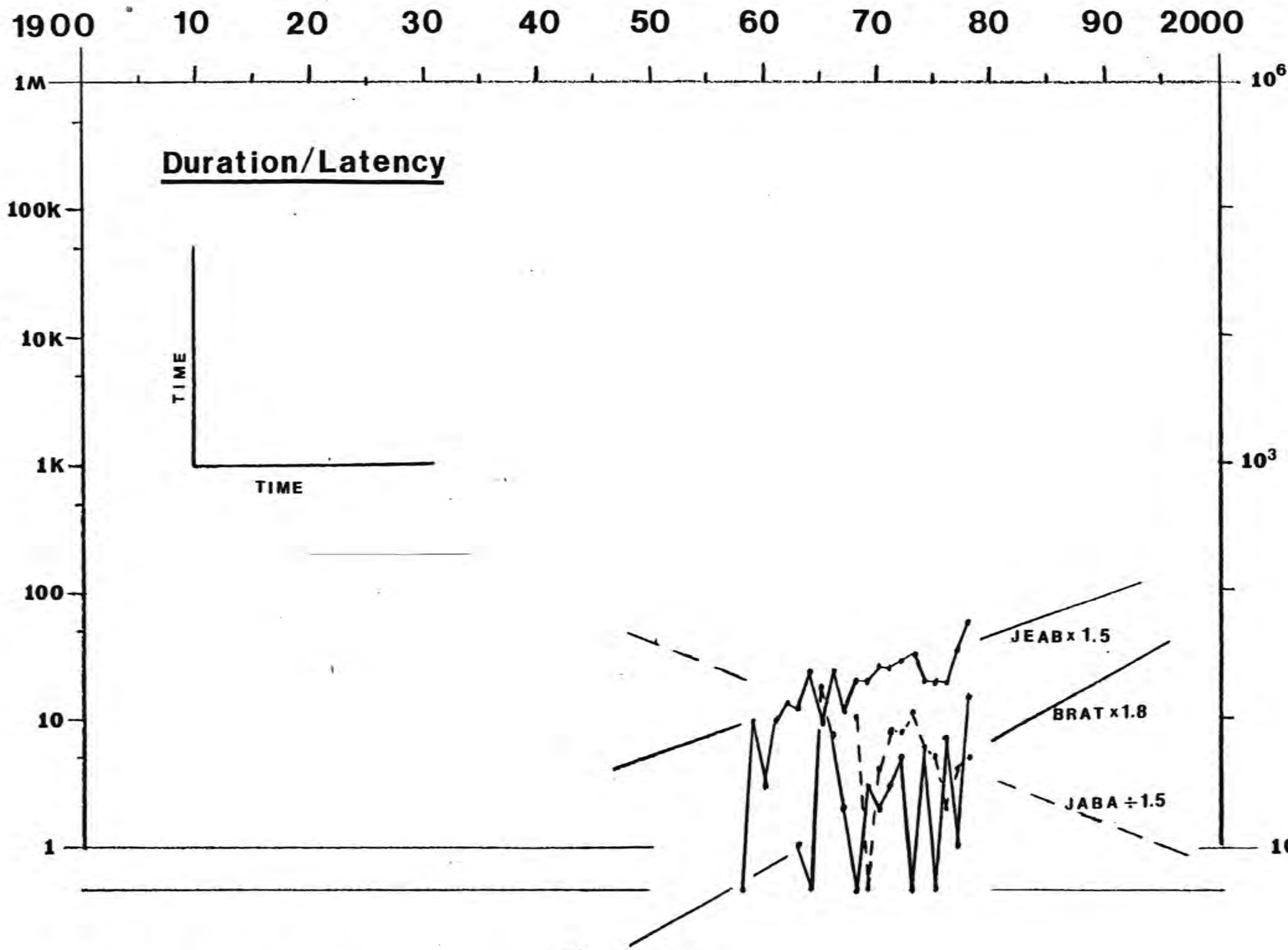

Figure 7

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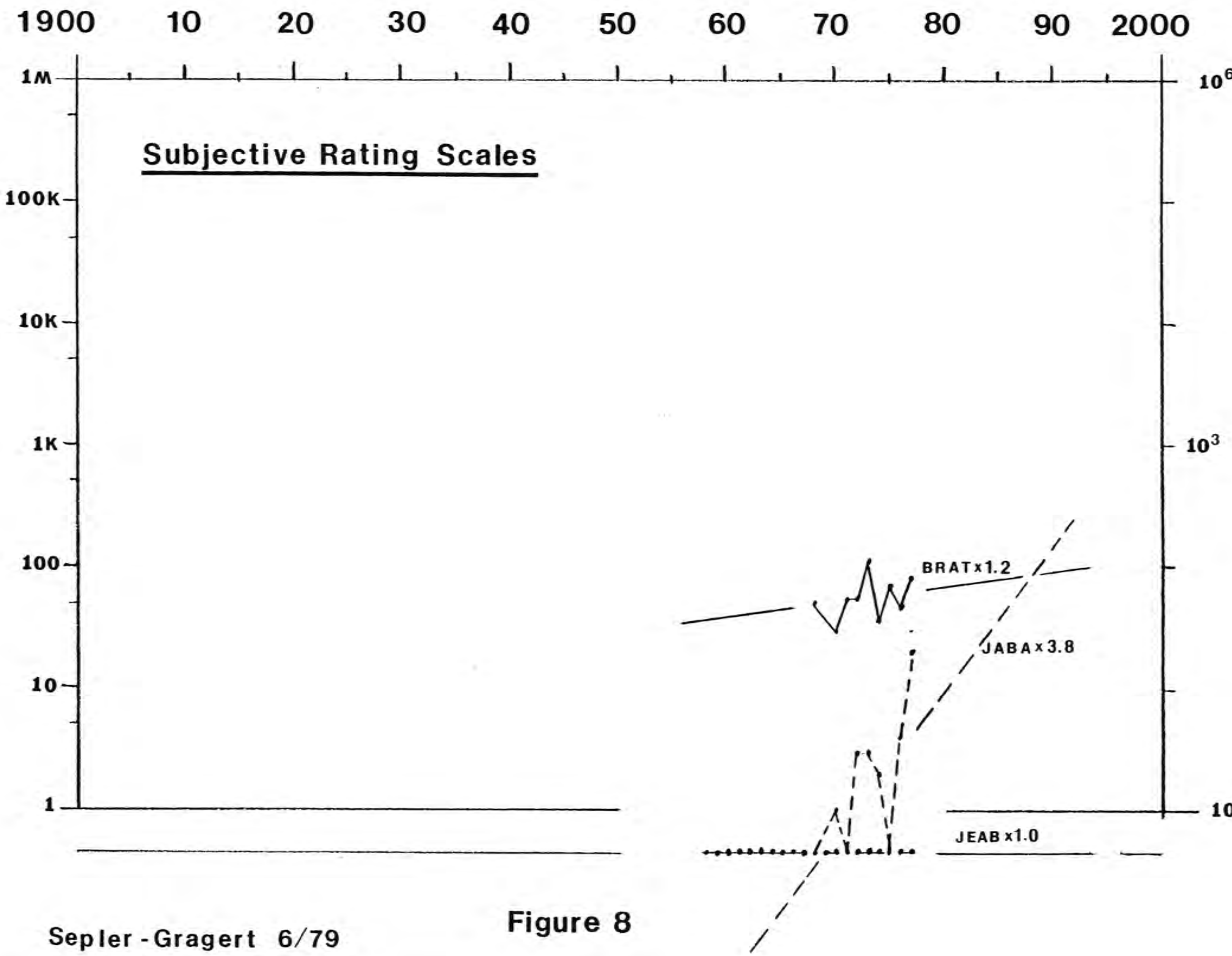

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Figure 8

TABLE 1

GROWTH OF BEHAVIOR MEASURES

RELATIVE TO TOTAL CHARTS

	Cumulative/ time	Number/time/ time	Percent
<u>JEAB</u>	÷ 1.75	x 1.2	x 1.28
<u>JABA</u>	x 1.0	x 1.5	x 1.67
<u>BRAT</u>	÷ 2.04	x 1.92	x 1.42

x indicates faster growth than the number of pages.

÷ indicates slower growth than the number of pages.