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THE ACCURACY OF TESTIMONY RELATIVE TO TIME INTERVALS

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A recent survey of over sixty years of scientific literature bearing upon testimonial accuracy yields but nine experimental studies in the recall of time intervals. To the almost neglected field have been added eight experiments conducted by the author during the last four years. A comparative analysis of these seventeen experiments should furnish a groundwork from which may be developed more productive studies in the future.

The studies relative to time interval divide themselves into two groups; those which seek the estimate of absolute time periods, and those which test for the comparison of two time intervals. Periods of time which may be estimated in terms of seconds are recalled with an accuracy little better than guessing. Incidents of one-minute duration were recalled by Morgan's students¹ as covering from one second to ten minutes. The police and court officials questioned by Smith² recalled a ten-second interval as from eight seconds to five minutes, while their estimates for a three-second period extended to half a minute. Other studies indicate recall estimates ranging from four seconds to five minutes for a 20-second interval,³ and from one second to 60 seconds for a four-second interval. Munsterberg's students⁴ gave ranges of from one-half second to 60 seconds for a ten-second interval. For a three-second interval the range extended from one-half second to fifteen. In all these cases the median estimate greatly exceeds the actual time. However, in another case, a 90-second interval was underestimated.

That such estimates often play an important part in court testimony is evident to one acquainted with the facts. The accident cited

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¹Morgan, John J. B., "Effect of Sound Distraction Upon Memory," *American Journal of Psychology*, April, 1917, vol. 28, pp. 191-208.

²Smith, Emory, "The Fallibility of Eye-Witness Testimony," *American Journal of Police Science*, 1930, vol. 1, pp. 487-95.

³Moore, E. H., "*Experimental Studies in Testimonial Accuracy*," Appendix B—VII (in preparation).

⁴Munsterberg, Hugo, "*On the Witness Stand*," Clark Boardman, 1908.

by Professor Payer,⁵ in which certain witnesses testified that the street car was stationary and others that it went three feet after the plaintiff fell is not necessarily an example in perjury. "A car moving at five miles an hour would cover about seven feet in one second. Those witnesses had to be right, therefore, within one-half of one second. The lawyer argued (and he was right), that if they saw the car at the beginning of the half second, the car may have been moving; if at the end of the half second, it may have been standing. If it is difficult for the mind to measure a half second, how much more difficult is it to measure the beginning and end of it."

An array was made of median estimates for fourteen time intervals ranging from two to nineteen minutes, anticipating that some order might be in evidence. The writer found no consistent tendency to underestimate long periods and to overestimate short periods, although certain studies had indicated such tentative conclusions. The array which follows shows a more general tendency to overestimate the two and four-minute periods and to underestimate the eight to nineteen-minute periods.

<i>Interval (Minutes)</i>	<i>Median Estimate (Minutes)</i>
2	2
2	3
4	5
4	5
4	5
4	8
4	8 (delayed)
4	11 (delayed)
8	5
8	14
8	20 (delayed)
12	6
19	19

It is interesting to observe that the courts limit testimony concerning the speed of an automobile to absolute estimates, thus "25 miles an hour" would be acceptable but "as fast as a horse can run," whether horse be specific or generic, is not accepted.⁶

Estimates in the recall of periods involving minutes reveal but slightly greater accuracy than those involving seconds. Besterman⁷ discovered a range of from five to forty minutes in the recall of a

⁵Payer, "Psychology of a Law Suit," *American Law Review*, April, 1922, vol. 56, pp. 187-205.

⁶See "Testimony as to Comparative Speed in Automobile Cases," *Iowa Law Review*, 1931, vol. 17, pp. 105-107.

⁷Besterman, T., "Psychology of Testimony in Relation to Paraphysical Phenomena," *Proceedings of the Society for Research*, May, 1932, vol. 40, pp. 365-87.

nineteen minute period. One of Moore's studies⁸ gave ranges of from thirty seconds to twenty minutes for a two-minute period, and from fifteen seconds to ten minutes for an eight-minute period.

Lest unwarranted conclusions should be drawn from this presentation, one must remember that periods of 60 and 90 seconds have often been underestimated when compared with shorter time intervals. As suggested by Romanes over fifty years ago,⁹ the estimate of a time interval doubtless depends upon its experience content. The interval during which there is a comparative absence of events appears protracted, while that including many events appears shortened.¹⁰

In this connection a significant experiment is reported by Burt.¹¹ His subjects estimated duration of time intervals 24 seconds, 48 seconds, and 72 seconds in length. These intervals were experienced under conditions of idleness, listening to the reading of a story, and rapid writing from dictation. While the average recall of all intervals were overestimated the error increased with the degree of inactivity. When writing, the overestimation was 13%, when listening 31%, but when idle, 49%. The conclusion of Romanes that states of consciousness have value as time measurers to the degree that they have reference to their own sequence finds its verification in the ordered condition of modern life. The student or man of affairs whose activity is compassed by time-regulated business and school routines has innumerable points of reference not possessed by one living an unregulated life.¹²

When estimates of time can be associated with certain normal activities or activities which lend themselves to the estimate of time periods, or when certain time "posts" can be established in the action, then estimates may become surprisingly accurate. In addition, one must also be aware that excellent accuracy may be obtained whenever actuality conforms to stereotype time interval.

Aside from an adaptation of Morgan's findings, studies dealing with the estimates of relative time intervals are confined to those of the present writer. Morgan's¹³ analysis indicated a tendency to

⁸Moore, E. H., "Experimental Studies in Testimonial Accuracy," Appendix B—IX (in preparation).

⁹Romanes, George J., "Consciousness of Time," *Mind*, 1878, vol. II, pp. 297-304.

¹⁰McDougall, Robert, "Sex Differences in the Sense of Time," *Science*, May, 1904 (reported by C. C. Moore, "A Treatise on Facts," p. 1003).

¹¹Burt, H. E., *Legal Psychology*, Prentice-Hall, New York, 1931.

¹²For judicial recognition of this fact, see "The General Rucker," 35 Fed. Rep. 152, 156. Also "Moore on Facts," p. 872, pp. 1004-1005.

¹³*Supra*.

equalize unequal periods of time, a conclusion which is substantiated by my own studies. The estimates for twenty-second and four-second intervals between three successive interruptions show no essential differences in range. In fact, nine of the twenty-two subjects estimated the twenty seconds as less than the four.¹⁴ In another study¹⁵ 73 subjects tested for recall, estimates of 15 and 90-second intervals presented the following distributions:

<i>Time Estimate Seconds</i>	<i>Percentage Who So Estimated 15-Second Interval</i>	<i>90-Second Interval</i>
0-30	27%	26%
31-90	49%	44%
Over 90.....	24%	30%

In this case nearly two-thirds of the subjects estimated the 15-second interval as greater than the 90. This tendency to equalize the periods, while evident, is not so pronounced for longer time intervals. Sixty of 68 subjects recalled a twelve-minute interval as longer than a two-minute interval. While 85% placed the two-minute interval as between one and three minutes, only 14% placed the twelve-minute interval in this classification. The median estimate for the longer period, however, was but three times that of the shorter.¹⁶ Similarly eight and two-minute intervals received median estimates of five and three, 75 of the 81 estimates tending to equalize the unequal ratio.¹⁷ In another experiment¹⁸ equal intervals of four minutes each were presented for immediate and delayed recall. These intervals represented the periods of time between certain major and minor disturbances in the corridor adjoining the classroom. The groups tested immediately presented median estimates of 5-5 and 5-8, while the group tested 48 hours later presented medians of 8 and 11. In a similar experiment¹⁹ using twenty-second and two-minute intervals, the immediate estimates gave medians of one minute and three minutes. But two of the 21 subjects presented a ratio as great as six to one in their recall. One should recognize here the tendency of subjects to give answers in multiples of five; especially is this true in

¹⁴Moore, *supra*.
¹⁵Moore, E. H., "Experimental Studies in Testimonial Accuracy," Appendix B—IV (in preparation).
¹⁶Moore, E. H., "Experimental Studies in Testimonial Accuracy," Appendix B—V (in preparation).
¹⁷Moore, *supra*, Appendix B—IX.
¹⁸Moore, E. H., "Experimental Studies in Testimonial Accuracy," Appendix B—VIII (in preparation).
¹⁹Moore, E. H., "Experimental Studies in Testimonial Accuracy," Appendix B—VI (in preparation).

the case of delayed recall, where such estimates were twice as numerous as those for non-multiples of five.

An additional experiment was set up to determine the accuracy in the perception of time intervals where the students had been warned beforehand. Without reference to time-pieces, but doubtless employing verbal and other aids, 25 and 75-second periods were estimated with medians falling on 30 and 80 seconds.

A summary of the various tests on relative time periods may be presented as follows:

RELATIONSHIP OF INTERVALS PRESENTED			
<i>Actual</i>		<i>Estimated</i>	
20"	: 4"	30"	: 30"
15"	: 90"	60"	: 60"
20"	: 120"	60"	: 180"
8'	: 2'	5'	: 3'
12'	: 2'	6'	: 2'
4'	: 4'	5'	: 5'
4'	: 4'	5'	: 8'
4'	: 4'	8'	: 11' (Delayed)

It would appear that accuracy of estimates of relative periods improves with longer time intervals. The following summary chart places in array the comparative range of estimates or medians for all tests where this information is available. This presentation reveals a greater tendency to overestimate time periods of a few seconds and to underestimate those involving years.

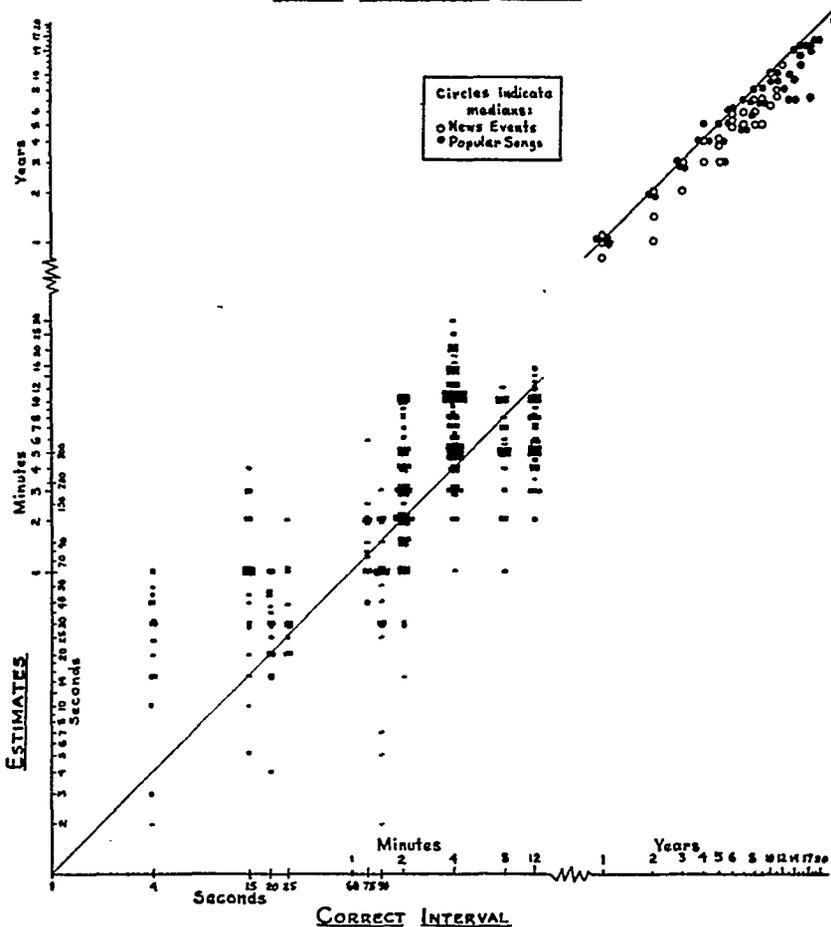
For estimates of longer periods Kuraner²⁰ found that an interval of one week was estimated as from five to twenty days. Two studies by Moore relate themselves to the recall of periods involving months and years. The detailed analysis of the recall of the year of appearance of popular music²¹ and the date of news events²² indicates a marked tendency to underestimate periods of time involving years rather than to overestimate them. This tendency shows a significant consistency for songs or events appearing in the same year. It was further noted that the absolute error tended to increase with an increase in time interval to be recalled. Conversely, the accurate recall of time intervals for events and music increased as the interval decreased. This movement was more nearly rectilinear for the faculty

²⁰Kuraner, Alfred, "Consistency of Testimonial Accuracy," *Journal of Criminal Law and Criminology*, September, 1931, vol. 22, pp. 406-14.

²¹Moore, E. H., "Experimental Studies in Testimonial Accuracy," Appendix B—XI (in preparation).

²²Moore, E. H., "Experimental Studies in Testimonial Accuracy," Appendix B—XII (in preparation).

Summary of
TIME INTERVAL TESTS



group than for the student group. In the latter it was more hyperbolic in nature; that is, with an abrupt increase for items representing intervals of less than two years. The relatively high accuracy in the recall of songs associated with the War period, the more successful recall of season than year in the case of events, and the beneficial influence of kinesthetic associations²³ would indicate that "time-posts" and not consciousness of elapsed time intervals governs our estimates of time.

²³Mainwaring, J., "Kinaesthetic Factors in the Recall of Musical Experience," *British Journal of Psychology*, 1932, vol. 23, pp. 284-307.