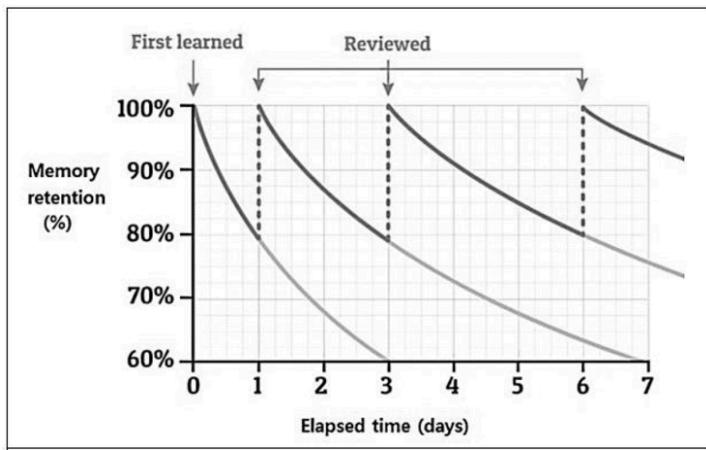


The curve:



Article:

### Replication and Analysis of Ebbinghaus Forgetting Curve

Citation: Murre JMJ, Dros J (2015) Replication and Analysis of Ebbinghaus' Forgetting Curve. PLoS ONE 10(7): e0120644. doi:10.1371/journal.pone.0120644

Key insights:

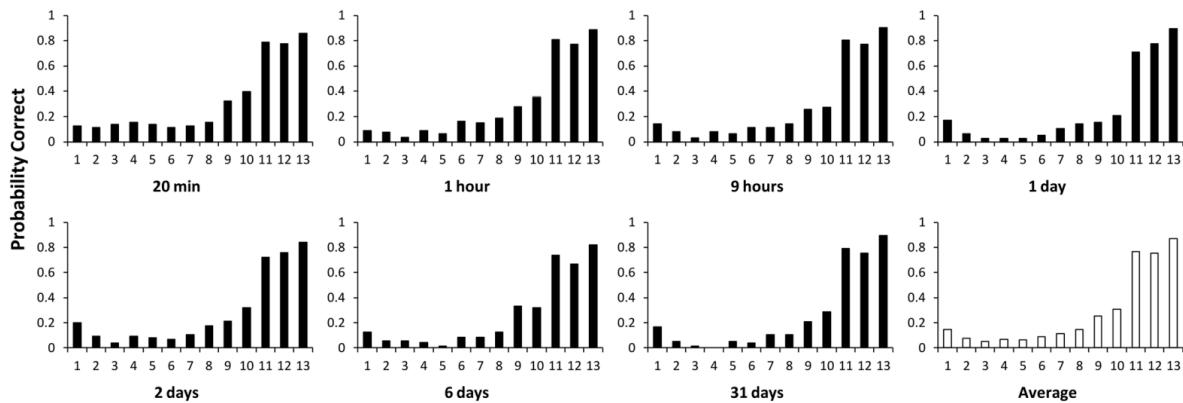
- Ebbinghaus only used himself as a subject, and based on seven months of experimentation. This research also only had one person as a subject.
- They run 10 replications per time interval instead of 12 to 45 by Ebbinghaus (the data is larger), and they don't test it at a fixed time of day.
- Time spent for learning and relearning with calculated saving scores:

Table 2. Time spent learning (session S1) and relearning (session S2) for each list with savings (Q) by Dros.

List	20 min			1 hour			9 hours			1 day			2 days			6 days			31 days		
	S1	S2	Q	S1	S2	Q	S1	S2	Q	S1	S2	Q	S1	S2	Q	S1	S2	Q	S1	S2	Q
1	1405	670	0.523	1690	1280	0.243	1815	1240	0.317	1670	1105	0.338	1710	1195	0.301	1780	1370	0.230	1480	1380	0.068
2	1840	1210	0.342	1790	1330	0.257	1780	1350	0.242	1840	1325	0.280	1635	1340	0.180	1605	1560	0.028	1680	1450	0.137
3	1830	1100	0.399	2070	1235	0.403	1935	1350	0.302	1930	1205	0.376	1950	1580	0.190	1870	1545	0.174	1770	1530	0.136
4	2180	960	0.560	1875	1130	0.397	1525	975	0.361	1740	1365	0.216	1935	1440	0.256	2020	1805	0.106	1440	1510	-0.049
5	1800	840	0.533	1775	1245	0.299	1770	1275	0.280	1875	1410	0.248	1830	1500	0.180	2090	1785	0.146	1650	1760	-0.067
6	1815	1345	0.259	1765	1170	0.337	1815	1335	0.264	1710	1215	0.289	2130	1485	0.303	1740	1585	0.089	1890	1785	0.056
7	2040	1110	0.456	1680	1125	0.330	1635	1220	0.254	1905	1325	0.304	1890	1440	0.238	1710	1350	0.211	1815	1745	0.039
8	1725	865	0.499	1905	1250	0.344	1845	1380	0.252	2095	1235	0.411	2085	1460	0.300	2025	1665	0.178	1910	1505	0.212
9	1935	1320	0.318	1805	1155	0.360	1950	1585	0.187	1860	1290	0.306	1740	1335	0.233	2100	1415	0.326	1490	1260	0.154
10	1830	1235	0.325	2065	1325	0.358				1980	1275	0.356	1695	1375	0.189	1890	1275	0.325	1710	1395	0.184
Average	1840	1066	0.421	1842	1225	0.335	1786	1301	0.271	1861	1275	0.315	1860	1415	0.239	1883	1536	0	1684	1532	0.090

doi:10.1371/journal.pone.0120644.t002

- Average serial position curves for each retention interval and the grand average:



**Fig 6.** Serial position for correct relearning scores for each retention interval and for the average of all retention intervals (see text for an explanation).

doi:10.1371/journal.pone.0120644.g006

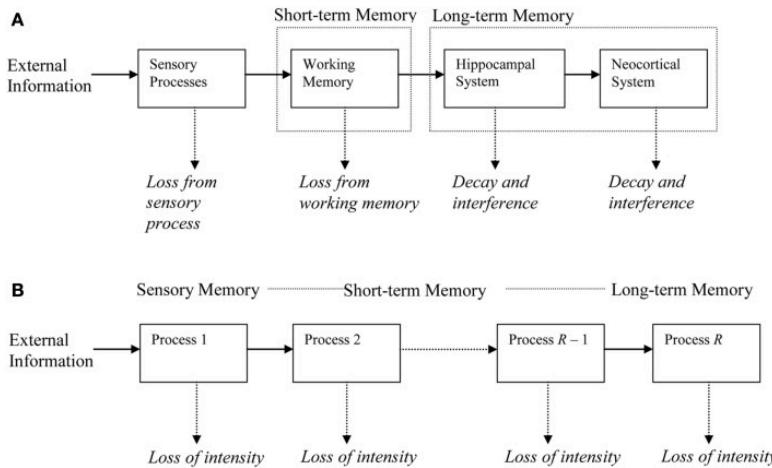
- The result curve is similar to Ebbinghaus and two subjects in an earlier replication (with the saving value at 31 days, much lower than the other three experiments)
- Effects of serial position on forgetting: the nature of saving methods with lists of nonsense syllables (savings experiments are very different from normal memory retention experiments where the subject learning something at after some time interval, savings → retention measurement itself consists of relearning the original material in repeated recall trials to stimulus materials)
- Curve fitting (test equation  $x = 1 - (2/t)^{0.0099} ]^{0.51}$ )

**Table 4. Fits of two equations proposed by Ebbinghaus in 1880 and 1885 to data from his own study and from three replication studies.** See text for the meaning of the parameters. SSD is the sum of squared differences between data and fitted curve,  $R^2$  is proportion variance explained, and AIC is the Akaike Information Criterion. To stay close to Ebbinghaus' own estimates, the parameters are fitted for time expressed in minutes.

	<b>Ebbinghaus</b>	<b>Mack</b>	<b>Seitz</b>	<b>Dros</b>	<b>Average</b>
<i>Ebbinghaus 1880 'Power' Function</i>					
$\mu_1$	0.523	0.325	0.248	0.516	
$a_1$	0.101	0.0518	0.0525	0.14	
SSD	0.00224	0.0107	0.0043	0.0177	0.00871
$R^2$	0.998	0.989	0.993	0.972	0.988
AIC	-30.5	-19.5	-26	-16	-23
<i>Ebbinghaus 1885 'Logarithmic' Function</i>					
$\mu_1$	1.8	1.34	0.9	1.36	
$a_1$	1.21	0.873	0.82	1.34	
SSD	0.00218	0.00976	0.00403	0.0212	0.00928
$R^2$	0.998	0.99	0.993	0.966	0.987
AIC	-30.6	-20.2	-26.4	-14.7	-23.

doi:10.1371/journal.pone.0120644.t004

- Memory chain model → has the same number of parameters but arranged differently, lies primarily in the fact that its parameters can be interpreted more clearly, associated with a type of consolidation mechanism, and that also explains other types of data than the saving function.



- The classic forgetting curve is not completely smooth, but it does show a jump at the 1 day retention interval

From the Ebbinghaus curve, there's 2-7-30 memory rule (not many article related to this)

<https://www.studyingmachine.com/the-2-7-30-method-a-simple-system-to-remember-almost-everything-you-learn/>

- Ebbinghaus experiment result: after 20 minutes, we retain 58%, after 1 hour we retain 44%, after 1 day we retain 33%, after 6 days we retain 25%
- First review: 2 days after initial learning (50-60% information has already been forgotten)
- Second review: information feels more familiar than in the first review
- Final review: revisiting material should feel almost effortless