

## Statistical Significance: What It Means, and What It Does Not Mean

Alpha, the significance level, is the probability of obtaining a particular value for a test statistic when the null hypothesis is true. An alpha of .05 for a dataset means that, if the null hypothesis were true, then the data would be unusual (occur only 5% of the time) based on sampling variability alone. It is the probability of making a Type 1 error when the null hypothesis is true.

In research, this does not mean that there is a 5% chance of making a Type 1 error because when we conduct a study we do not know if the null hypothesis is true or not. If the null hypothesis is false, the probability of making a Type 1 error is zero -- a Type 1 error cannot be made. Yet alpha may still be .05. Across many studies, alpha indicates the proportion of Type 1 errors only if the researchers were always testing true null hypotheses. Given that at least some theories/hypotheses are reasonable and true, and that the null hypothesis is false at least some of the time, then alpha provides only an unrealistic upper limit on the number of Type 1 errors.

When we decide to reject the null hypothesis, alpha is not the probability that the null hypothesis is true, it is not the probability of making a Type 1 error, it is not the probability that our results are due to chance, and it is not an indication that our findings are likely to replicate. There is nothing about alpha levels that gives us this information. There is nothing about p levels that tell you whether e.g., a control group and a treatment group were drawn from different populations. Alpha levels are always based on the null hypothesis being true. They are not probability statements about the truthfulness of the null hypothesis.

the probability of A given B [ $p(A B)$ ]	<b>is not the same as</b>	the probability of B given A [ $p(B A)$ ]
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the probability of these data given the null hypothesis [ $p(D^* H)$ ]	<b>is not the same as</b>	the probability of the null hypothesis given these data [ $p(H D^*)$ ]
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the probability of a population of firemen generating a person in uniform (high)	<b>is not the same as</b>	the probability that a sample person in uniform was generated by a population of firemen (low)
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if this person is a Canadian, then it is unlikely that he or she is a member of parliament (TRUE)	this person is a member of parliament, therefore it is unlikely that he or she is a Canadian (FALSE)
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if the null hypothesis is true, these data are unlikely (TRUE, when e.g., $p < .05$ )	these data occurred, therefore the null hypothesis is unlikely (UNKNOWN; ALPHA IS NOT INFORMATIVE)
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