



### Figuring the odds—How probability is Calculated

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Probability is a more precise mathematical tool for determining if results are random.

The exact probability that a person guesses the correct ESP symbol exactly x times out of 25 is:

$$Px = \binom{25}{x} (.2)^x (.8)^{25-x}$$

$$\text{where } \binom{25}{x} = \frac{25!}{x!(25-x)!}$$

is the number of ways to choose x different numbers between 1 and 25 (order not important).

A very good approximation can be obtained by approximating the histogram by a normal distribution with a mean  $25(.2) + 5$  and standard deviation  $\sqrt{25(.2)(.8)} = 2$ . The probability of guessing 3 to 7 correct is approximately the area under the normal curve between 2.5 and 7.5 ... about 79%.

**Probability** predicts these test results for a test of 25 questions with five possible answers if chance is operating:

Most people (79%) will get between 3 and 7 correct (probability is a more precise calculation).

The probability of guessing 8 or more correctly is 10.9% (in a group of 25, you can always expect several scores in this range purely by chance.)

The chances of getting 15 correct is about 1 in 90,000.

Guessing 20 out of 25 has a probability of about 1 in 5 billion.

Guessing all 25 correct has a chance of  $(.2) = 3.3 \times 10$ , or about 1 in 300 quadrillion! (A wager against such an unusual occurrence would be a safe bet.)