## **V REVIEW OF STATISTICAL POWER**

The power of a statistical measure is defined as the probability of a significant observation given that an effect hypothesis  $(H_1)$  is true. Define the value of a dependent variable as X. Then, given that the null hypothesis  $(H_0)$  is true, a significant observation, x, is defined as one in which the probability of observing

$$x\geq \mu_0+1.645\sigma_0,$$

where  $\mu_0$  and  $\sigma_0$  are the mean and standard deviation of the parent  $H_0$  distribution, is less than or equal to 0.05.

Figure 3 shows these definitions in graphical form under the assumption of normality. The *Z-Score* is a normalized representation of the dependent variable and is given by:

$$z = \frac{(x - \mu_0)}{\sigma_0},$$

where x is the value of the dependent variable and  $\mu_0$  and  $\sigma_0$  are the mean and standard deviation, respectively, of the parent distribution under  $H_0$ , and  $z_c$  is the minimum value (i.e., 1.645) required for significance (one-tailed). The mean of z under  $H_0$  is zero. The mean and standard deviation of z under  $H_1$  are  $\mu_{AC}$  and  $\sigma_{AC}$ , respectively.

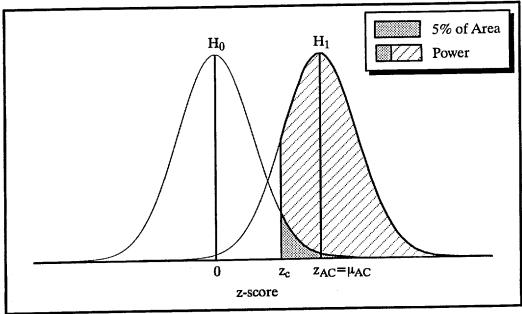


Figure 3. Normal Representation of Statistical Power

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In general the effect size,  $\varepsilon$ , may be defined as:

$$\varepsilon = \frac{z}{\sqrt{n}},\tag{3}$$

where n is the sample size. Let  $\varepsilon_{AC}$  be the empirically derived effect size for anomalous cognition (AC). Then  $z_{AC} = \mu_{AC}$  in Figure 3 is computed from Equation 3. From Figure 3 we see that power is defined by:

Power = 
$$\frac{1}{\sigma_{AC}\sqrt{2\pi}} \int_{z_C}^{\infty} e^{-0.5\left(\frac{\zeta - \mu_{AC}}{\sigma_{AC}}\right)^2} d\zeta.$$
 (4)

Let

$$z = \frac{\varsigma - \mu_{AC}}{\sigma_{AC}}.$$

Then Equation 4 becomes

Power = 
$$\frac{1}{\sqrt{2\pi}} \int_{z'c}^{\infty} e^{-0.5z^2} dz$$
, where  $z'_c = \frac{z_c - \mu_{AC}}{\sigma_{AC}}$ . (5)

For planning purposes, it is convenient to invert Equation 5 to determine the number of trials that are necessary to achieve a given power under the  $H_1$  hypothesis. If we define z(P) to be the z-score associated with a power, P, then the number of trials required is given by:

$$n = \frac{4z^2(P)}{\varepsilon_{AC}^2},\tag{6}$$

where  $\varepsilon_{AC}$  is the estimated mean value for the effect size under H<sub>1</sub>. Figure 4 shows the power, calculated from Equation 5, for various effect sizes for  $z_c = 1.645$ .

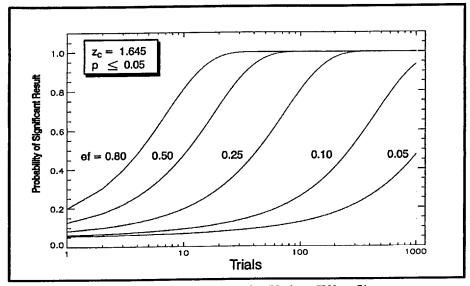


Figure 4. Statistical Power for Various Effect Sizes