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| **GLIMMPSE: Power Service REST API** |

Contents

[**GLIMMPSE: Power Service REST API** 1](#_Toc342858395)

[1 Introduction 3](#_Toc342858396)

[1.1 License Information 3](#_Toc342858397)

[1.2 Funding 3](#_Toc342858398)

[2 The Power Service 4](#_Toc342858399)

[3 Inputs to Power and Sample Size Calculations: The Study Design Object 4](#_Toc342858400)

[3.1 Required Components for *Matrix* Designs 5](#_Toc342858401)

[3.1.1 Required Matrices 5](#_Toc342858402)

[3.1.2 Matrix Dimensions 7](#_Toc342858403)

[3.2 Required Components for *Guided* Designs 8](#_Toc342858404)

[3.2.1 Required Inputs for *Guided* Designs 8](#_Toc342858406)

[3.2.2 Optional Inputs for *Guided* Designs 8](#_Toc342858407)

[3.3 List Inputs 9](#_Toc342858408)

[3.3.1 Test List 9](#_Toc342858409)

[3.3.2 Power List 9](#_Toc342858410)

[3.3.3 Alpha List 9](#_Toc342858411)

[3.3.4 Per Group Sample Size List 9](#_Toc342858412)

[3.3.5 The Relative Group Size List 10](#_Toc342858413)

[3.3.6 Beta Scale List 10](#_Toc342858414)

[3.3.7 Sigma Scale List 10](#_Toc342858415)

[3.3.8 Power Method List 10](#_Toc342858416)

[3.3.9 Quantile List 11](#_Toc342858417)

[3.4 Confidence Intervals 11](#_Toc342858418)

[4 The REST API 11](#_Toc342858419)

[4.1 Calculating Power 11](#_Toc342858420)

[4.2 Calculating Sample Size 12](#_Toc342858421)

[4.3 Calculating Detectable Difference 12](#_Toc342858422)

[5 Examples 12](#_Toc342858423)

[5.1 One-Sample T-Test 12](#_Toc342858424)

[5.2 One-Way ANOVA 13](#_Toc342858425)

#  Introduction

The GLIMMPSE software system provides a web based user interface to calculate power and sample size for the general linear multivariate model (GLMM)1 with or without a baseline covariate. The GLIMMPSE system consists of five main components:

* Glimmpse.com user interface - a GWT front-end user interface
* **Power Service** - Java web service which processes power and sample size requests
* Chart Service - Java web service which produces graphs. For the Glimmpse system, this service produces power curves.
* File Service - Java web service providing upload and save functionality for study design information
* JavaStatistics library - low level library containing routines for computing GLMM power
* Web Service Common library – a library defining the communication layer between the Glimmpse user interface and the web services.

This document describes the REST API for the Power Service, version 2.0.0. It assumes basic familiarity with [HTTP](http://www.w3.org/Protocols/), [REST](http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm), and the GLMM. For additional background on GLMM power calculations when controlling for a baseline covariate, please see Glueck and Muller2.

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## Funding

GLIMMPSE version 2.0.0 is funded by NIDCR 1 R01 DE020832-01A1 to the University of Florida (Keith E. Muller, PI; Deborah Glueck, University of Colorado site PI)

Previous funding was received from an American Recovery and Re-investment Act supplement (3K07CA088811-06S) for NCI grant K07CA088811.

# The Power Service

The Power Service component of the GLIMMPSE system is a Java web service which processes requests for power and sample size for the GLMM. The system supports GLMM study designs with fixed predictors (GLMM(F)), or fixed predictors with a single baseline covariate (GLMM(F,g)). The REST API allows users to specify the matrices required for GLMM power calculations, and request power, or sample size. Users may request a list of power results which can then be displayed in tables or as power curves.

The system is implemented using the [Restlet Framework](http://www.restlet.org/). Requests to the power service are received via an AJAX call from the Glimmpse user interface, and data is encoded as JSON. For version 2.0.0, power and sample size results are not persistent, so the service deviates slightly from the standard definition of create/update/delete in the REST philosophy.

The Power Service was developed and tested for use within the [Apache Tomcat Server (v 7.0)](http://tomcat.apache.org/).

# Inputs to Power and Sample Size Calculations: The Study Design Object

Power calculations for the GLMM are based on several matrices which describe the study design, choices for regression coefficients, choices for variability, and study hypotheses. Users may request multiple power values in a single request to the power service, including variations such as different statistical tests, Type I error rates, sample sizes, desired power values, and scale factors for regression coefficients and variability. For GLMM(F,g) designs, multiple power methods and quantiles may be specified.

For version 2.0.0 of the power service, all requests to the power service must include a JSON encoded StudyDesign object. A full description of the Study Design object can be found in the API document for the Web Service Common library (see <http://samplesizeshop.org/documentation/glimmpse/> for more details). Any calling application which interacts with the power service should compile against Web Service Common to ensure proper communication of the StudyDesign object.

A StudyDesign object describes all aspects of a study design relevant to power and sample size calculations. The StudyDesign object takes two forms: a *matrix* based design, or a *guided* design. In a *matrix* design, the StudyDesign contains a set of all matrices required for the calculation. In a *guided* design, the calling application sends a StudyDesign object with components describing between- and within-participant factors, the primary hypothesis, variability, and other relevant information. In this case, the power service will translate the *guided* study design into the appropriate set of matrices.

The following JSON object contains a *guided* StudyDesign for a two sample t-test comparing the mean between two groups A and B on the outcome Y.

{"uuid":null,"name":null,"gaussianCovariate":false,"solutionTypeEnum":"POWER","participantLabel":"participant","viewTypeEnum":"GUIDED\_MODE","confidenceIntervalDescriptions":null,"powerCurveDescriptions":null,"alphaList":[{"idx":0,"alphaValue":0.05}],"betaScaleList":[{"idx":0,"value":1}],"sigmaScaleList":[{"idx":0,"value":1}],"relativeGroupSizeList":null,"sampleSizeList":[{"idx":0,"value":20}],"statisticalTestList":[{"idx":0,"type":"HLT"}],"powerMethodList":null,"quantileList":null,"nominalPowerList":null,"responseList":[{"idx":0,"name":"Y"}],"betweenParticipantFactorList":[{"idx":0,"predictorName":"trt","categoryList":[{"idx":0,"category":"A"},{"idx":0,"category":"B"}]}],"repeatedMeasuresTree":null,"clusteringTree":null,"hypothesis":[{"idx":0,"type":"MAIN\_EFFECT","betweenParticipantFactorMapList":[{"type":"NONE","betweenParticipantFactor":{"idx":0,"predictorName":"trt","categoryList":[{"idx":0,"category":"A"},{"idx":0,"category":"B"}]}}],"repeatedMeasuresMapTree":null}],"covariance":[{"idx":0,"type":"UNSTRUCTURED\_CORRELATION","name":"\_\_RESPONSE\_COVARIANCE\_\_","standardDeviationList":[{"idx":0,"value":2}],"rho":-2,"delta":-1,"rows":1,"columns":1,"blob":{"data":[[1]]}}],"matrixSet":[{"idx":0,"name":"beta","rows":2,"columns":1,"data":{"data":[[1],[0]]}}]}

## Required Components for *Matrix* Designs

The power service supports two types of matrix inputs.

* NamedMatrix - a simple *r x c* matrix
* Fixed Random Matrix

A NamedMatrix is an *r x c* matrix, reprenseted as a 2-dimensional array of real numbers with *r* rows and *c* columns.

A fixed random matrix is a 2-dimensional array of real numbers, which is separated into both a fixed submatrix and a random submatrix. Both the regression coefficient matrix (β) and the between participant contrast matrix (C) are represented as fixed/random matrices. These matrices will have both fixed and random components for GLMM(F,g) designs.

### Required Matrices

This section describes the individual matrices that must be specified for a power or sample size calculation.

#### The Design Essence Matrix

The fixed portion of the study design matrix should be specified as a NamedMatrix with name “design”. There are no restrictions on the coding scheme, although the design matrix should be full rank. The design matrix represents the study design for fixed predictors. Please see Muller and Stewart1 for more details.

#### The Between Participant Contrast Matrix

A single between participant contrast matrix must be specified. The between participant contrast matrix ("C" matrix) defines the between participant hypotheses that the user wishes to test. When controlling for a baseline covariate, this matrix includes a random column vector with the same number of rows as the contrast matrix. It is most common to have 0's in this column - since the value of the baseline covariate is expected to differ across participants, between participant hypotheses do not typically involve the baseline covariate.

#### The Within Participant Contrast Matrix

The within participant contrast ("U" matrix) defines hypotheses on responses within the same participant (or other sampling unit).

#### The Theta Null Matrix

A single theta null matrix must be specified. The theta null matrix represents the null hypotheses for the contrasts defined in the C and U matrices. It is most common to have 0's in all cells of this matrix, although this depends on the specific hypotheses being tested.

#### The Beta Matrix

A single beta matrix must be specified. The beta matrix contains choices for regression coefficients for the model (the interpretation depends on the design matrix coding scheme). If the study design includes a baseline covariate, the matrix will include an additional "random" row to represent the coefficients for the baseline covariate. The values in this row will be automatically generated based on the covariance matrices described below, and should simply be filled with 1's.

#### The Covariance (Σ) Matrices

The sigma matrices represent the covariance the scientist expects to observe. Different matrices are specified for fixed designs as opposed to designs with a Gaussian covariate. In general, all sigma matrices should be symmetric and positive definite. All cell values along the diagonal must be positive real numbers. Off diagonal values should be real numbers.

##### Covariance in GLMM(F) Designs

When the study design contains only fixed predictors, a single "sigmaError" matrix is specified. This matrix represents the residual (or "error") covariance. For univariate study designs, this will be a 1x1 scalar value.

##### Covariance in GLMM(F,g)

For study designs including a baseline covariate, three matrices must be specified to fully describe the variability.

Covariance of Baseline Covariate (Σg)

The Σg matrix defines the variance in the baseline covariate. At present, GLIMMPSE only supports power and sample size calculations for designs with a single baseline covariate. Therefore, the matrix has dimensions 1x1.

Covariance of Responses (ΣY)

The ΣY matrix defines the covariance between responses on the same participant (or sampling unit). The matrix can be thought of as describing the error covariance for a design with the same fixed predictors, but excluding the baseline covariate. For univariate designs, this is a 1x1 matrix.

Covariance of Outcomes with Baseline Covariate (ΣYg)

The ΣYg matrix is a column vector defining the covariance between each outcome and the baseline covariate.

### Matrix Dimensions

For successful computation of power for the GLMM, the required matrices must conform appropriately to one another. The following table lists the dimensions required for each of the matrices:

|  |  |  |  |
| --- | --- | --- | --- |
| **Matrix** | **Rows** | **Columns** | **Conformance Details** |
| **X**: Design essence matrix | N | q | Columns equal number of rows in **β** |
| **C**: Between subject contrast | a | q | Columns equal number of rows in **β** Rows must be one less than number of rows in **X** |
| **U**: Within subject contrast | p | b | Rows equals the number of columns in **β** |
| **Θ**: Null hypothesis values | a | b | Rows equals the number of rows in **C**Columns equals the number of columns in **U** |
| **β**: Regression coefficient estimates | q | p | Rows equals the number of columns in **X** (number of predictors)Columns equals the number of columns in **U** (number of outcomes) |
| **GLMM(F) Designs** |
| **Σ**error: covariance matrix of residuals | p | p | Matrix is square and symmetric.Rows/columns equal the number of columns in **β** |
| **GLMM(F,g) Designs** |
| **Σ**g: Covariance of Gaussian predictor | 1 | 1 | Since only a single baseline covariate is allowed, this matrix is 1x1. |
| **Σ**Yg: Covariance of Gaussian predictor with outcomes | P | 1 | Rows equals the number of columns in **β** |
| **Σ**Y: Covariance of outcomes | P | P | Rows/columns equal the number of columns in **β** (i.e. number of outcomes) |

## Required Components for *Guided* Designs

For *guided* designs, the power service will automatically generate matrices from the StudyDesign object. We describe required and optional components of a *guided* StudyDesign object below.

### Required Inputs for *Guided* Designs

#### Response Variables List

The Response Variables list contains the names of the dependent variables in the study design. A *guided* StudyDesign object must included at least one response variable in the response variable list object.

#### Hypothesis

The hypothesis object indicates the type of hypothesis and between or within participant factors involved in the hypothesis. For grand mean hypotheses, the StudyDesign must also contain a NamedMatrix of null hypotheses. Main effect and trend hypotheses should include a single predictor of interest in the hypothesis object. Interaction hypotheses should include at least two predictors of interest.

#### Beta Matrix (Choices for Means)

The power service uses a cell means coding for all *guided* designs. Designs should include a beta matrix with choices for the cell means.

#### Covariance

Correlation can arise from multivariate response variables and from repeated measures. The StudyDesign should include a set of covariance objects, with one for the responses, and one for each dimension of repeated measures. For example, doubly-repeated measures design would have a total of three covariance objects. Covariance objects can be specified using the unstructured covariance format, the unstructured correlation format, or as a LEAR covariance structure.

### Optional Inputs for *Guided* Designs

#### Between Participant Factors

For study designs with two or more independent samples, the groups are specified by including between participant factors in the StudyDesign object. If no between participant factors are specified, the power service assumes a one sample design.

#### Clustering

In studies such as cluster randomized designs, the independent sampling unit is a cluster of participants, such as a school or neighborhood. The power service will automatically update the overall covariance structure for the model when clustering is included.

#### Repeated Measures

For longitudinal designs, the StudyDesign object may include up to three levels of nested repeated measures. StudyDesigns including repeated measures must be sure to include a covariance object for each level of repeated measures.

## List Inputs

Users may request a list of powers by varying the basic study design. Users can scale the regression coefficients in the beta matrix and the variability specified in the sigma matrix. Users may also specify several statistical tests, power methods (for designs with a baseline covariate), power values, alpha levels, and per group sample size values. The list subcomponents of the StudyDesign objects facilitate the calculation of multiple power or sample size values in a single request. Lists inputs are identical for both *matrix* and *guided* StudyDesign objects, except for the relative group size list which only appears in the *guided*  designs.

Note that each combination of values specified in these lists will produce a single power calculation. Therefore, list sizes should be minimized to avoid long processing times.

### Test List

The test list includes all statistical tests to be run. It is required for all requests. Power values should be equivalent for univariate designs regardless of the test selected. However, no uniformly most powerful test exists for the multivariate linear model. The following tests are supported:

* unirep - Univariate approach to repeated measures (uncorrected)
* unirepBox - Univariate approach to repeated measures with Box correction
* unirepGG - Univariate approach to repeated measures with Geisser-Greenhouse correction
* unirepHF - Univariate approach to repeated measures with Huynh-Feldt correction
* wl - Wilks' Lambda
* hlt - Hotelling-Lawley trace
* pbt - Pillai-Bartlett trace

### Power List

The power list includes all desired power values. It is valid for sample size or detectable difference requests (it is ignored for power requests). Each nominal power value is a decimal between 0 and 1. Researchers typically require a minimum of 80% power (0.80), so values between 0.80 and 1 are most common.

### Alpha List

The alpha list specifies various Type I error rates. It is required for all StudyDesign objects.

The Type I error rate is a decimal between 0 and 1. The most commonly used values are 0.01, 0.05, and 0.10, which correspond to confidence levels of 99%, 95%, and 90% respectively.

### Per Group Sample Size List

The per group sample size list includes all desired group sample sizes. It is valid for power or detectable difference requests (it is ignored for sample size requests). The total sample size for the power calculation is determined by multiplying the per group size by the number of rows in the design matrix.

For example, consider the following design essence matrix for a one-way ANOVA with 3 groups.

$X=\left[\begin{matrix}1&0&0\\0&1&0\\0&0&1\end{matrix}\right]$

For a per group sample size of 25, the total sample size would be 75. Each sample size in the list should be a positive integer greater than 1.

For unequal group sizes, the relative number of rows in the design essence matrix will change. For example, the same 3 group ANOVA with twice as many participants in the first group would be coded as

$X=\left[\begin{matrix}1&0&0\\1&0&0\\0&1&0\\0&0&1\end{matrix}\right]$ .

For a per group sample size of 25, the total sample would be 100.

### The Relative Group Size List

For *guided* designs, the calling application does not specify the design matrix. Thus, the relative sizes of study groups are specified in a list of relative group sizes. The power service will use the relative group size list to construct the appropriate design essence matrix for the power calculations.

### Beta Scale List

The beta scale list includes all scale factors for the regression coefficient, or beta, matrix. The beta scale list is valid for power and sample size requests (it is ignored for detectable difference requests).

### Sigma Scale List

The sigma scale list includes all scale factors for the error covariance matrix. The sigma scale list is required for all requests.

.

### Power Method List

The power method lists includes any combination of the conditional, unconditional, or quantile power methods. It is valid only for study designs involving a baseline covariate (ignored otherwise). Note that only the Hotelling-Lawley and univariate approach to repeated measures are supported for designs with a baseline covariate. The following power methods are supported:

* unconditional - Power based on numerical integration over possible values of the non-centrality parameter
* quantile - Power based on specific quantiles of the non-centrality parameter's distribution

### Quantile List

The quantile list specifies all quantiles for use with the "quantile" power method. This list is valid only for study designs with a baseline covariate, which specify quantile power in the power method list. A quantile is a real number between 0 and 1.

## Confidence Intervals

Both *guided* and *matrix* designs may optionally include a confidence interval description. The confidence interval object includes information about the data set from which the choices for means and variances were obtained. When present, the power service will calculate confidence intervals on the resulting power values.

# The REST API

## Calculating Power

New power calculations are "created" with the following URI:

POST /power/power/

The entity body should contain a JSON encoded StudyDesign object.

Power requests must contain all required matrices, a testList, an alphaList, a betaScaleList, a sigmaScaleList, and a sampleSizeList.

Power results are returned as a JSON encoded array of PowerResult objects.

[

{"nominalPower":{"idx":0,"value":0.9},"actualPower":0.9014701570140866,"totalSampleSize":97,"alpha":{"idx":0,"alphaValue":0.05},"betaScale":{"idx":0,"value":1.0},"sigmaScale":{"idx":0,"value":1.0},"test":{"idx":0,"type":"HLT"},"powerMethod":{"idx":0,"powerMethodEnum":"CONDITIONAL"},"quantile":null,"confidenceInterval":null,"errorCode":null,"errorMessage":null},

{"nominalPower":{"idx":0,"value":0.9},"actualPower":0.900605601227398,"totalSampleSize":381,"alpha":{"idx":0,"alphaValue":0.05},"betaScale":{"idx":0,"value":0.5},"sigmaScale":{"idx":0,"value":1.0},"test":{"idx":0,"type":"HLT"},"powerMethod":{"idx":0,"powerMethodEnum":"CONDITIONAL"},"quantile":null,"confidenceInterval":null,"errorCode":null,"errorMessage":null},

{"nominalPower":{"idx":0,"value":0.9},"actualPower":0.9042541650294551,"totalSampleSize":26,"alpha":{"idx":0,"alphaValue":0.05},"betaScale":{"idx":0,"value":2.0},"sigmaScale":{"idx":0,"value":1.0},"test":{"idx":0,"type":"HLT"},"powerMethod":{"idx":0,"powerMethodEnum":"CONDITIONAL"},"quantile":null,"confidenceInterval":null,"errorCode":null,"errorMessage":null}

]

The PowerResult object includes the following attributes

|  |  |  |
| --- | --- | --- |
| **Variable** | **Type** | **Description** |
| alpha | Real | Type I error rate associated with this power result. The value ranges from 0 to 1, although 0.01, 0.05, and 0.10 are typical. |
| nominalPower | Real | The desired power for this calculation (specified with sample size or detectable difference requests). For power requests, this value will be equal to the actualPower attribute. |
| actualPower | Real | The actual power associated with this power result. For sample size and detectable difference requests, it may not be possible to perfectly match the desired power for certain study designs. This value will be set to the calculated power associated with the sample size or detectable difference which most closely matches the desired power. |
| sampleSize | Real | The total sample size for this power result |
| betaScale | Real | The scale factor applied to the beta matrix for this power result. This value can be used to generate the beta matrix representing the detectable difference. |
| sigmaScale | Real | The scale factor applied to the error matrix for this power result |
| confidenceInterval | Object | The power confidence interval |

## Calculating Sample Size

New sample size calculations are "created" with the following URI:

POST /power/samplesize/

The entity body should contain a JSON encoded StudyDesign object. StudyDesign objects for sample size requests must include all [required matrices](file:///C%3A%5CDocuments%20and%20Settings%5Ckreidles%5CMy%20Documents%5Cworkspace%5CPowerSvc%5Cdocs%5Capi.html#paramsRequiredMatrices), a testList, an alphaList, a betaScaleList, a sigmaScaleList, and a powerList.

Results are returned as described in the [power results section](file:///C%3A%5CDocuments%20and%20Settings%5Ckreidles%5CMy%20Documents%5Cworkspace%5CPowerSvc%5Cdocs%5Capi.html#powerResults). The sample size results should be extracted from the sampleSize attribute in each PowerResult object.

## Calculating Detectable Difference

New detectable difference calculations are "created" with the following URI:

POST /power/difference/

The entity body should contain a JSON encoded StudyDesign object. Detectable difference requests must include all [required matrices](file:///C%3A%5CDocuments%20and%20Settings%5Ckreidles%5CMy%20Documents%5Cworkspace%5CPowerSvc%5Cdocs%5Capi.html#paramsRequiredMatrices), a testList, an alphaList, a sigmaScaleList, a sampleSizeList, and a powerList.

Results are returned as described in the [power results section](file:///C%3A%5CDocuments%20and%20Settings%5Ckreidles%5CMy%20Documents%5Cworkspace%5CPowerSvc%5Cdocs%5Capi.html#powerResults). Since regression coefficients are specified as a beta matrix, the "detectable difference" is found in the betaScale attribute of the glmmPower result. For easier interpretation of this value, the beta matrix should have a 1 in cells for groups expected to differ, and a 0 otherwise.

# Examples

## One-Sample T-Test

Suppose we are comparing mean height in sample of 200 adult males against a known height for US males. We will assume a standard deviation of 8 inches (i.e. variance = 64). We would like to determine the power for detecting a difference of 2 inches. We will use the univariate approach to repeated measures as our statistical test, and a type I error rate of 0.05.

To calculate power, we would send the following HTTP request to the Power Service:

POST /power/power

with the entity body:

{"uuid":null,"name":null,"gaussianCovariate":false,"solutionTypeEnum":"POWER","participantLabel":null,"viewTypeEnum":"GUIDED\_MODE","confidenceIntervalDescriptions":null,"powerCurveDescriptions":null,"alphaList":[{"idx":0,"alphaValue":0.05}],"betaScaleList":[{"idx":0,"value":1}],"sigmaScaleList":[{"idx":0,"value":1}],"relativeGroupSizeList":null,"sampleSizeList":[{"idx":0,"value":200}],"statisticalTestList":[{"idx":0,"type":"UNIREP"}],"powerMethodList":null,"quantileList":null,"nominalPowerList":null,"responseList":[{"idx":0,"name":"height"}],"betweenParticipantFactorList":null,"repeatedMeasuresTree":null,"clusteringTree":null,"hypothesis":[{"idx":0,"type":"GRAND\_MEAN","betweenParticipantFactorMapList":null,"repeatedMeasuresMapTree":null}],"covariance":[{"idx":0,"type":"UNSTRUCTURED\_CORRELATION","name":"\_\_RESPONSE\_COVARIANCE\_\_","standardDeviationList":[{"idx":0,"value":8}],"rho":-2,"delta":-1,"rows":1,"columns":1,"blob":{"data":[[1]]}}],"matrixSet":[{"idx":0,"name":"beta","rows":1,"columns":1,"data":{"data":[[2]]}},{"idx":0,"name":"thetaNull","rows":1,"columns":1,"data":{"data":[[0]]}}]}

This yields the results:

[{"nominalPower":{"idx":0,"value":0.9404375882823021},"actualPower":0.9404375882823021,"totalSampleSize":200,"alpha":{"idx":0,"alphaValue":0.05},"betaScale":{"idx":0,"value":1.0},"sigmaScale":{"idx":0,"value":1.0},"test":{"idx":0,"type":"UNIREP"},"powerMethod":{"idx":0,"powerMethodEnum":"CONDITIONAL"},"quantile":null,"confidenceInterval":null,"errorCode":null,"errorMessage":null}]

Indicating that power = 0.94 to detect a difference of 2 inches.

## One-Way ANOVA

Suppose we are comparing resting heart rate in individuals taking three drugs A, B, and C. There are equal numbers of participants taking each drug. We wish to determine the power for detecting a difference of 5 beats/min between the groups, when there are 10, 15, or 20 participants in each group. We will use a cell means coding (3x3 identity matrix) for our study design. We assume a within-group variance of 20 and Type I error rate of 0.05.

To calculate power, we would send the following HTTP request to the Power Service:

POST /power/power

with the entity body:

{"uuid":null,"name":null,"gaussianCovariate":false,"solutionTypeEnum":"POWER","participantLabel":null,"viewTypeEnum":"MATRIX\_MODE","confidenceIntervalDescriptions":null,"powerCurveDescriptions":null,"alphaList":[{"idx":0,"alphaValue":0.05}],"betaScaleList":[{"idx":0,"value":5}],"sigmaScaleList":[{"idx":0,"value":1}],"relativeGroupSizeList":null,"sampleSizeList":[{"idx":0,"value":10},{"idx":0,"value":15},{"idx":0,"value":20}],"statisticalTestList":[{"idx":0,"type":"UNIREP"}],"powerMethodList":null,"quantileList":null,"nominalPowerList":null,"responseList":null,"betweenParticipantFactorList":null,"repeatedMeasuresTree":null,"clusteringTree":null,"hypothesis":null,"covariance":null,"matrixSet":[{"idx":0,"name":"design","rows":3,"columns":3,"data":{"data":[[1,0,0],[0,1,0],[0,0,1]]}},{"idx":0,"name":"beta","rows":3,"columns":1,"data":{"data":[[1],[0],[0]]}},{"idx":0,"name":"betweenSubjectContrast","rows":2,"columns":3,"data":{"data":[[1,-1,0],[1,0,-1]]}},{"idx":0,"name":"withinSubjectContrast","rows":1,"columns":1,"data":{"data":[[1]]}},{"idx":0,"name":"thetaNull","rows":2,"columns":1,"data":{"data":[[0],[0]]}},{"idx":0,"name":"sigmaError","rows":1,"columns":1,"data":{"data":[[20]]}}]}

This yields the results:

[{"nominalPower":{"idx":0,"value":0.6843301311850013},"actualPower":0.6843301311850013,"totalSampleSize":30,"alpha":{"idx":0,"alphaValue":0.05},"betaScale":{"idx":0,"value":5.0},"sigmaScale":{"idx":0,"value":1.0},"test":{"idx":0,"type":"UNIREP"},"powerMethod":{"idx":0,"powerMethodEnum":"CONDITIONAL"},"quantile":null,"confidenceInterval":null,"errorCode":null,"errorMessage":null},

{"nominalPower":{"idx":0,"value":0.8724721326514673},"actualPower":0.8724721326514673,"totalSampleSize":45,"alpha":{"idx":0,"alphaValue":0.05},"betaScale":{"idx":0,"value":5.0},"sigmaScale":{"idx":0,"value":1.0},"test":{"idx":0,"type":"UNIREP"},"powerMethod":{"idx":0,"powerMethodEnum":"CONDITIONAL"},"quantile":null,"confidenceInterval":null,"errorCode":null,"errorMessage":null},

{"nominalPower":{"idx":0,"value":0.9543921012166517},"actualPower":0.9543921012166517,"totalSampleSize":60,"alpha":{"idx":0,"alphaValue":0.05},"betaScale":{"idx":0,"value":5.0},"sigmaScale":{"idx":0,"value":1.0},"test":{"idx":0,"type":"UNIREP"},"powerMethod":{"idx":0,"powerMethodEnum":"CONDITIONAL"},"quantile":null,"confidenceInterval":null,"errorCode":null,"errorMessage":null}]

This indicates that the design has 68% power with 10 participants per group, 87% power with 15 participants per group, and 95% power with 20 participants per group.

**References**

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Last Updated: December 9, 2012