Is there a map? How can we answer this question objectively?

In all of them?

The number of measurement sites is limited a topographic map exists, for example where:

Identified by eye

How can this be quantified?

In a topographic map, the ordering or neighbourhood feature space.

For concreteness, we use examples with a 1-D dimensionality of feature space varies.

Map space is often 2-D (e.g. cortical maps). The underlying map is smooth over the whole area of the map. In the nonlinear models, the spatial scale of feature distances is controlled by a scale parameter σ.

The spatial scale of smoothness in the map is important. In the linear map model, the underlying map is smooth over the whole area of the map.

The scale parameter σ of the map is used to control the smoothness of the map. In the nonlinear model, the scale parameter σ controls the smoothness of the underlying map.

We quantify topography by calculating the correlation between pairwise distances in map and feature spaces [2, 3]. Different combinations of distance metrics lead to different map measures variants.

Use measures to quantify the degree of topographic order

We also considered the topographic product (TP), another measure that quantifies the preservation of neighbour orderings (1st, 2nd, 3rd nearest neighbour etc.) between map and feature spaces, on Euclidean distances [4].

We assessed the suitability of the seven map measures for map detection by calculating their statistical power when used to detect three types of model topographic map, based on simulated experimental data (Fig.3): 1) Use measures to quantify the degree of topographic order; 2) Assess significance via permutation test; 3) Repeat many times and calculate statistical significance.

Using the FC measure, data from several subjects can be pooled into a single permutation test. This approach can be used to increase statistical power where the number of data from each individual subject is severely limited.

We define a topographic map in terms of two spaces: Feature space (space of the selectivity property); Map space (anatomical space).

Map space is often 2-D (e.g. cortical maps). The dimensionality of feature space varies.

For convenience, we use examples with a 1-D feature space.

In a topographic map, the ordering or neighbourhood relations between points are similar in both spaces.

Figure 1A: Is there a map?

One aspect of neuronal selectivity, mapped using serial unit recordings in the same cortical region in four animals. The mapped area is approximately three square in each case. Data relates to selectivity within a single neuron cluster in pallid A1 [1].

Is the aspect of neuronal selectivity shown in Figure 1 organised topographically?

1) In the order of the exemplars?

2) In all of them?

3) In the population in general?

Is there a map? How can we answer this question objectively?

• Identify a measure that quantifies the level of topographic organisation

• Use this measure as a test statistic to determine whether a map is significant

Figure 2: Feature and map spaces

We considered the topographic product (TP), another measure that quantifies the preservation of neighbour orderings (1st, 2nd, 3rd nearest neighbour etc.) between map and feature spaces, on Euclidean distances [4].

We assessed the suitability of the seven map measures for map detection by calculating their statistical power when used to detect three types of model topographic map, based on simulated experimental data (Fig.3): 1) Use measures to quantify the degree of topographic order; 2) Assess significance via permutation test; 3) Repeat many times and calculate statistical significance.

Using the FC measure, data from several subjects can be pooled into a single permutation test. This approach can be used to increase statistical power where the number of data from each individual subject is severely limited.

We define a topographic map in terms of two spaces: Feature space (space of the selectivity property); Map space (anatomical space).

Map space is often 2-D (e.g. cortical maps). The dimensionality of feature space varies.

For convenience, we use examples with a 1-D feature space.

In a topographic map, the ordering or neighbourhood relations between points are similar in both spaces.

How can this be quantified?

Figure 3: Map models

Map models: (A) linear map, (B) angle map [5], (C) clusters. Plot axes represent map space dimensions, e.g. colour represents feature space dimension (case Fig.2).

Sampling and deprivation with noise: (D) quasi-random spatial sampling of neuron locations; (E) output from sampling. (F) Gaussian noise is added to z. SNR determines map strength (here SNR = 5).

Figure 4: Map detection statistical power

Comparison of map measures statistical power when detecting (A) linear maps, (B) angle maps and (C) clusters. Power is summarised by the quantity N80, the mean number of points required to achieve a statistical power of 80%; this is shown as a function of the SNR of a

Panels D–F show the relative powers of the measures. Here N80 is normalised by Nbest, the N80 of the most powerful measure for a given map type and SNR.

Table 1. Combining measures for map detection

Table 2. Combining measures for map detection

The spatial scale of smoothness in the map is important. In the linear map model, the underlying map is smooth over the whole area of the map. In the nonlinear models, the spatial scale of feature distances is controlled by a scale parameter σ.

The spatial scale of smoothness in the map is important. In the linear map model, the underlying map is smooth over the whole area of the map. In the nonlinear models, the spatial scale of feature distances is controlled by a scale parameter σ.

References


