CLAIMS

1. A method for improving performance on a conscious activity, the method comprising:

collecting behavioral data and neurophysiological data while a person performs the conscious activity;

assessing the behavioral data by comparing the behavioral data with reference data to score the person's conscious activity in an assessment;

synchronizing the behavioral data with the neurophysiological data;

inputting the behavioral data, neurophysiological data, and the assessment into a machine learning system; and

training the machine learning system with said inputs to identify a probabilistic relationship between the person's neurophysiological data and the person's performance.

2. The method of claim 1, wherein the neurophysiological data is brain activity data.

3. The method of claim 2, further comprising transforming the neurophysiological data into a sequence of discrete brain states.

4. The method of claim 2, further comprising performing a clustering operation on a large set of functional connectivity matrices.

5. The method of claim 1, further comprising:

decomposing the behavioral data and neurophysiological data into spatial and temporal components that reflect a functional connectivity state at an instant of time;

repeating said decomposing step for a sequence of instances; and

using machine learning, clustering a plurality of functional connectivity matrices into a set of discrete steps.

6. The method of claim 1, wherein the step of training a machine learning system with the behavioral data and neurophysiological data and assessments involves two machine learning layers, including:

a first machine learning layer in which the neurophysiological data is decomposed into neurophysiological states that a person experienced; and

a second machine learning layer that receives temporal sequences of neurophysiological states and correlates different sequential patterns of said states with probabilities of performing the activity well.

7. The method of claim 5, wherein characteristic neurophysiological states are identified by:

decomposing the neurophysiological data;

identifying components associated with variances in or sources of the neurophysiological data;

bandpassing the components across several frequency bands;

finding correlations between envelopes of the bandpassed components; and

clustering the correlation data.

8. A method for improving performance on an activity, the method comprising:

collecting behavioral data and neurophysiological data while a person performs the activity; grading the person's performance quality using comparisons of behavioral data with reference data;

using a first machine learning system to estimate functional connectivity patterns from the neurophysiological data;

training a second machine learning system with the functional connectivity patterns and the grades to identify relationships between the functional connectivity patterns and performance quality;

applying an output of the second machine learning system to predict the quality of the person's subsequent performance of the activity on the basis of further functional connectivity state estimations based on neurophysiological data collected from the person.

9. A system for improving performance on an activity, the system comprising:

a human-machine interface that collects neurophysiological data while a person performs the activity;

a computer configured to assess the behavioral data by comparing it with reference data in order to distinguish optimal behavior from sub-optimal behavior; and

a machine learning system configured to receive and train upon at least one of the behavioral data, the neurophysiological data, assessments of the behavioral data, assessments

of the neurophysiological data, derivatives of the behavioral data, and derivatives of the neurophysiological data, as inputs;

wherein the computer is further configured to apply an output of the machine learning system to predict the person's performance during a subsequent performance of the activity.

10. The system of claim 9, wherein the computer is further configured to at least one of augment, complement, and override subsequent performances of the activity by the person.

11. A system for improving performance on an activity, the system comprising:

a human-machine interface that collects behavioral data and neurophysiological data while a person performs the activity;

a computer configured to assess the behavioral data to distinguish optimal behavior from sub-optimal behavior; and

a machine learning system configured to receive and train upon the at least one of the behavioral data, the neurophysiological data, assessments of the behavioral data, assessments of the neurophysiological data, derivatives of the behavioral data, and derivatives of the neurophysiological data, as inputs;

wherein the computer is further configured to apply an output of the machine learning system to predict the person's performance during a subsequent performance of the activity.

12. A non-transitory computer-readable medium having instructions stored thereon that are capable of causing or configuring a processor for biofeedback to improve a person's performance on an activity, the instructions performing the following functions:

collecting behavioral data and neurophysiological data while a person performs the activity; grading the person's performance quality using comparisons of behavioral data with reference data;

using a first machine learning system to estimate functional connectivity patterns from the neurophysiological data;

training a second machine learning system with the functional connectivity patterns and the grades to identify relationships between the functional connectivity patterns and performance quality; and

applying an output of the second machine learning system to predict the quality of the person's subsequent performance of the activity on the basis of further functional connectivity state estimations based on neurophysiological data collected from the person.

13. A method for improving performance on an activity or decision, the method comprising: training a machine learning system to generate a prediction model that outputs a probability distribution of outcomes of performance on the activity or decision;

wherein the machine learning system is trained on past behavioral data from at least one person performing the activity, neurophysiological data collected from the at least one person performing the activity or decision, and performance assessments based on a ranking of the person's activity against reference data;

wherein after the prediction model is generated, the prediction model, when fed with data about the near real time activity or decision data, outputs a probability distribution of possible outcomes of the near real time activity or decision.

14. The method of claim 13, further comprising negating, mitigating or augmenting the action, or cancelling, downweighting or upweighting the decision on the basis of the probability distribution.

15. A system for identifying brain states in which a person is likely to at least one of overperform and underperform on an activity, the system comprising:

a sensor interface including one or more sensors attached to the person that generate data indicative of the brain states of the person while the person is performing the activity;

a platform that collects performance data about performance of the activity; and

a data processing pipeline that collects the sensor data from the sensor interface, the performance data from the platform, and at least one performance metric pertinent to measuring at least one of overperformance and underperformance of the activity;

the data processing pipeline also identifying characteristic brain states associated with at least one of overperformance and underperformance in performing the activity.

16. The system of claim 15, wherein the sensor data is brain activity data, and the data processing pipeline identifies characteristic brain states by decomposing the brain activity data by preprocessing and transforming the brain activity data to identify components associated with variances in or sources of the brain activity data, bandpassing the components across several frequency bands, finding correlations between envelopes of the bandpassed components, and clustering the correlation data.

17. The system of any of claim 15, wherein:

the sensors are EEG sensors; and

the data processing pipeline filters and decomposes EEG signal data taken from the EEG sensors across both spatial and frequency domains and constructs correlation matrices across spatial and frequency components.

18. The system of any of claim 15, wherein:

the sensors are EEG sensors; and

the data processing pipeline filters signal data taken from an electrode space, transforms the signal data into a principal-component space, identifies a temporal evolution of spatial components of the principal-component space, and finds a correlation between the spatial components based on the temporal evolution.

19. A method for identifying brain states in which a person is likely to at least one of overperform and underperform in performing an activity, the method comprising:

using a sensor interface that includes one or more sensors that generate sensor data indicative of the brain states of the person while the person is performing the activity;

collecting performance data about performance of the activity through a data interface; collecting the sensor data from the sensor interface and the performance data from the data interface; and

identifying characteristic brain states associated with at least one of overperformance and underperformance in performing the activity.

20. The method of claim 19, wherein:

the sensor data is brain activity data; and

the step of identifying characteristic brain states comprises:

decomposing the brain activity data by preprocessing and transforming the brain activity data to identify components associated with variances in or sources of the brain activity data;

bandpassing the components across several frequency bands;

finding correlations between envelopes of the bandpassed components; and clustering the correlation data into clusters representative of brain states.