Claims

1. A system for facilitating a subject's functional development, wherein the subject is experiencing at least one of a functional shortcoming, functional inadequacy, functional impairment and functional dysregulation, the system comprising:

a first set of sensing devices configured for sensing signals corresponding to the subject's mind state;

a second set of sensing devices configured for sensing signals corresponding to the subject's body state; and

a set of processing resources configured for generating a mind – body synergy measure that corresponds to an expected extent to which each of the subject's mind state and the subject's body state are cooperatively aligned with respect to facilitating the subject's functional development,

wherein the set of processing resources is configured for generating each of (a) a mind state alignment measure corresponding to an expected extent to which the subject's mental activity is conducive to learning, and (b) a body state alignment measure corresponding to an expected extent to which the subject's bodily activity is conducive to successfully performing a functional development activity,

wherein the body state alignment measure corresponds to a measure of agonist – antagonist muscle contraction; and

a set of display devices configured for presenting a visual functional development activity sequence to the subject that conveys at least one target movement of at least one model body part, the visual functional development activity sequence intended for at least one of performance, attempted performance, and imagined performance by the subject by way of at least one subject body part that is a mirror image of the at least one model body part, wherein the visual functional development activity sequence is presented concurrently with the subject's at least one of performance, attempted performance, and imagined performance of the visual functional development activity sequence,

wherein the set of display devices is further configured for presenting to the subject a visual representation of a level of subject activation of each of an agonist muscle and an antagonist muscle associated with subject performance, attempted performance or imagined performance of the functional

development activity sequence concurrently with the presentation of the visual functional development activity sequence to the subject.

2. The system of claim 1, wherein the first set of sensing devices comprises a set of devices configured for detecting signals representative of intracranial neural activity.

3. The system of claim 2, wherein the first set of sensing devices comprises a set of EEG signal detection elements.

4. The system of claim 1, wherein the second set of sensing devices comprises a set of devices configured for detecting signals corresponding to peripheral nervous system activity.

5. The system of claim 3, wherein the second set of sensing devices comprises a set of EMG signal detection elements.

~~6. The system of claim 1, wherein the set of processing resources is configured for generating each of (a) a mind state alignment measure corresponding to an expected extent to which the subject's mental activity is conducive to learning, and (b) a body state alignment measure corresponding to an expected extent to which the subject's bodily activity is conducive to successfully performing a functional development activity.~~

~~7~~6. The system of claim ~~6~~1, wherein the mind state alignment measure corresponds to at least one of a level of stress, a level of anxiety, a level of mental relaxation, and a level of mental attention or focus.

~~8~~7. The system of claim ~~7~~6, wherein the mind state alignment measure is correlated with a ratio between a mean relative alpha band power measure $\bar{P}_{\alpha}$ and a delta-to-alpha measure DAR referenced to a particular time t, normalized to a baseline or at rest ratio between the mean relative alpha measure $\bar{P}_{\alpha}$ and the delta-to-alpha measure DAR.

~~9. The system of claim 6, wherein the body state alignment measure corresponds to a measure of agonist – antagonist muscle contraction.~~

~~10~~8. The system of claim ~~9~~1, wherein the body state alignment measure is correlated with a difference between a measure of voluntary target agonist muscle contraction and a measure of voluntary target antagonist muscle contraction.

~~11~~9. The system of claim ~~6~~1, wherein the mind – body synergy measure includes a breakthrough measure that is expected to correspond to a likelihood that the subject's mind state and body state can synergistically facilitate at least one of substantial, accelerated, sudden, nonlinear, surprising, spontaneous, and lasting gains in functional capability.

~~12~~10. The system of claim ~~11~~9, wherein the breakthrough measure is correlated with a voluntary muscle contraction measure that (a) meets or exceeds a threshold muscle contraction condition, and which (b) is temporally associated with each of the mind state alignment measure satisfying a mind state alignment condition and the body state alignment measure satisfying a body state alignment condition.

~~13~~11. The system of claim 1, further comprising a set of display devices configured for presenting to the subject each of ~~a~~the visual functional development activity sequence and a visual representation of at least one of the mind – body synergy measure, a measure of subject relaxed mental attention, a measure of subject bodily tension, a measure of subject heart rate, a measure of subject skin conductance, a measure of subject sweat, a measure of subject blood oxygenation, and a target subject breathing rate.

~~14. The system of claim 13, wherein the set of display devices is configured for presenting a visual functional development activity sequence that conveys at least one target movement of at least one model body part, the visual functional development activity sequence intended for at least one of performance, attempted performance, and imagined performance by the subject by way of at least one subject body part that is a mirror image of the at least one model body part.~~

~~15. The system of claim 13, wherein the set of display devices is further configured for presenting to the subject a visual representation of a level of subject activation of each of an agonist muscle and an antagonist muscle associated with subject performance or attempted performance of the functional development activity sequence.~~

~~16~~12. The system of claim ~~13~~11, wherein the set of display devices is further configured for selectively presenting mind state training exercises and body state training exercises to the subject.

~~17~~13. The system of claim 1, wherein at least a portion of the system is wearable by the subject.

~~18~~14. The system of claim ~~16~~12, wherein the system is wearable by the subject.

~~19~~15. The system of claim ~~14~~11, further comprising at least one of a robotic orthosis configured for providing movement assistance to the subject and a functional electrical stimulation (FES) apparatus configured for delivering FES signals to the subject.

~~20~~16. The system of claim ~~19~~15, wherein the robotic orthosis comprises:

a set of appendage motion modules configured for engaging with a portion of a subject appendage;

a set of mechanical power interface modules coupled to the set of appendage motion modules and configured for facilitating movement of appendage motion modules within the set of appendage motion modules; and

a set of flexible drive shafts couplable to the set of mechanical power interface modules and a set of motors external to the wearable robotic orthosis,

wherein the set of appendage motion modules and the set of mechanical power interface modules are subject wearable.

~~21~~17. The system of claim ~~20~~16, wherein the set of appendage motion modules includes multiple independently operable and selectively detachable appendage motion modules.

~~22~~18. A method for facilitating functional development of a subject, wherein the subject is experiencing at least one of a functional shortcoming, functional inadequacy, functional impairment and functional dysregulation, the method comprising:

sensing signals corresponding to the subject's mind state;

sensing signals corresponding to the subject's body state; and

generating a mind – body synergy measure that corresponds to an expected extent to which each of the subject's mind state and the subject's body state are cooperatively aligned with respect to facilitating the subject's functional development;

generating each of (a) a mind state alignment measure corresponding to an expected extent to which the subject's mental activity is conducive to learning, and (b) a body state alignment measure corresponding to an expected extent to which the subject's bodily activity is conducive to successfully performing a functional development activity,

wherein the body state alignment measure corresponds to a measure of agonist – antagonist muscle contraction;

presenting a visual functional development activity sequence to the subject that conveys at least one target movement of at least one model body part, the visual functional development activity sequence intended for at least one of performance, attempted performance, and imagined performance by the subject by way of at least one subject body part that is a mirror image of the at least one model body part, wherein the visual functional development activity sequence is presented concurrently with the subject's at least one of performance, attempted performance, and imagined performance of the visual functional development activity sequence; and

presenting to the subject a visual representation of a level of subject activation of each of an agonist muscle and an antagonist muscle associated with subject performance, attempted performance or imagined performance of the functional development activity sequence concurrently with the presentation of the visual functional development activity sequence to the subject.

~~23~~19. The method of claim ~~22~~18, wherein sensing signals corresponding to the subject's mind state comprises detecting signals representative of intracranial neural activity.

~~24~~20. The method of claim ~~22~~18, wherein sensing signals corresponding to the subject's mind state comprises sensing EEG signals.

~~25~~21. The method of claim ~~19~~18, wherein sensing signals corresponding to the subject's body state comprises detecting signals corresponding to peripheral nervous system activity.

~~26~~22. The method of claim ~~22~~18, wherein sensing signals corresponding to the subject's body state comprises sensing EMG signals.

~~27. The method of claim 22, further comprising generating each of (a) a mind state alignment measure corresponding to an expected extent to which the subject's mental activity is conducive to learning, and (b) a body state alignment measure corresponding to an expected extent to which the subject's bodily activity is conducive to successfully performing a functional development activity.~~

~~28~~23. The system of claim ~~27~~18, wherein the mind state alignment measure corresponds to at least one of a level of stress, a level of anxiety, a level of mental relaxation, and a level of mental attention or focus.

~~29~~24. The method of claim ~~28~~23, wherein the mind state alignment measure is correlated with a ratio between a mean relative alpha band power measure $\bar{P}_{\alpha}^{-}$ and a delta-to-alpha measure DAR referenced to a particular time t, normalized to a baseline or at rest ratio between the mean relative alpha measure $\bar{P}_{\alpha}^{-}$ and the delta-to-alpha measure DAR.

~~30. The method of claim 27, wherein the body state alignment measure corresponds to a measure of agonist – antagonist muscle contraction.~~

~~31~~25. The method of claim ~~30~~18, wherein the body state alignment measure is correlated with a difference between a measure of voluntary target agonist muscle contraction and a measure of voluntary target antagonist muscle contraction.

~~32~~26. The method of claim ~~27~~18, wherein the mind – body synergy measure includes a breakthrough measure that is expected to correspond to a likelihood that the subject's mind state and body state can synergistically facilitate at least one of substantial, accelerated, sudden, nonlinear, surprising, spontaneous, and lasting gains in functional capability.

~~33~~27. The method of claim ~~32~~26, wherein the breakthrough measure is correlated with a voluntary muscle contraction measure that (a) meets or exceeds a threshold muscle contraction condition, and which (b) is temporally associated with each of the mind state alignment measure satisfying a mind state alignment condition and the body state alignment measure satisfying a body state alignment condition.

~~34~~28. The method of claim ~~27~~18, further comprising presenting to the subject each of ~~a~~the visual functional development activity sequence and a visual representation of at least one of the mind – body synergy measure, a measure of subject relaxed mental attention, a measure of subject bodily tension, a measure of subject heart rate, a measure of subject skin conductance, a measure of subject sweat, a measure of subject blood oxygenation, and a target subject breathing rate.

~~35. The method of claim 34, wherein presenting the visual functional development activity sequence comprises presenting at least one target movement of at least one model body part, the visual functional development activity sequence intended for at least one of performance, attempted performance, and imagined performance by the subject by way of at least one subject body part that is a mirror image of the at least one model body part.~~

~~36. The method of claim 34, further comprising presenting to the subject a visual representation of a level of subject activation of each of an agonist muscle and an antagonist muscle associated with subject performance or attempted performance of the functional development activity sequence.~~

~~37~~29. The method of claim ~~34~~28, further comprising selectively presenting to the subject a set of mind state training exercises in the event that a set of mind state alignment measures corresponds to a subject mind state that is expected to be counterproductive to subject functional development.

~~38~~30. The method of claim ~~37~~29, further comprising automatically resuming presentation of the functional development activity sequence to the subject following presentation of the set of mind state training exercises to the subject.

~~39~~31. The method of claim ~~34~~28, further comprising selectively presenting to the subject a set of body state training exercises in the event that a set of body state alignment measures corresponds to a subject body state that is expected to be counterproductive to subject functional development.

~~40~~32. The method of claim ~~22~~18, wherein sensing signals corresponding to the subject's mind state and sensing signals corresponding to the subject's body state occurs during one of subject involvement in a therapy session and subject performance or attempted performance of activities of daily living.

~~41~~33. The method of claim ~~22~~18, wherein sensing signals corresponding to the subject's mind state, sensing signals corresponding to the subject's body state, and generating the mind – body synergy measure occurs during one of subject involvement in a therapy session and subject performance or attempted performance of activities of daily living.

~~42~~34. The method of claim ~~22~~18, further comprising:

mounting a wearable robotic orthosis to a portion of a subject appendage; and

providing assistive movement to the subject appendage by way of the wearable robotic orthosis during subject performance or attempted performance of at least one of a functional development activity sequence and an activity of daily living.

~~43. A method for facilitating a subject's functional development, the method comprising:~~

~~presenting to the subject a set of activities involving a model body part;~~

~~simultaneously engaging the subject in attempted imitation of the set of activities by way of attempted movement of a subject body part that is a mirror image of the model body part;~~

~~simultaneously presenting to the subject an indication of an expected extent to which each of the subject's mind state and body state are cooperative with respect to subject performance of the set of activities; and~~

~~simultaneously presenting to the subject an indication of an extent of subject relaxation.~~

~~44. A robotic orthosis system configured for providing assistive movement to a portion of an appendage of a subject, the robotic orthosis system including a robotic orthosis comprising:~~

~~a set of appendage motion modules configured for engaging with a portion of a subject appendage;~~

~~a set of mechanical power interface modules coupled to the set of appendage motion modules and configured for facilitating movement of appendage motion modules within the set of appendage motion modules; and~~

~~a set of flexible drive shafts couplable to the set of mechanical power interface modules,~~

~~wherein the set of appendage motion modules and the set of mechanical power interface modules are subject wearable.~~

~~45. The robotic orthosis system of claim 44~~36~~, further comprising a set of motors external to the robotic orthosis, the set of motors couplable to the set of mechanical power interface modules by way of the set of flexible drive shafts.~~

~~46. An EEG headset comprising:~~

~~at least one flexible band configured for fittable engagement with a subject's head; and~~

~~a set of dry EEG electrode assemblies carried by the at least one flexible band, each dry EEG electrode assembly comprising an array of resiliently biased EEG sensing elements,~~

~~wherein the set of dry EEG electrode assemblies are position adjustable relative to each of an anterior – posterior direction and a superior – inferior direction.~~