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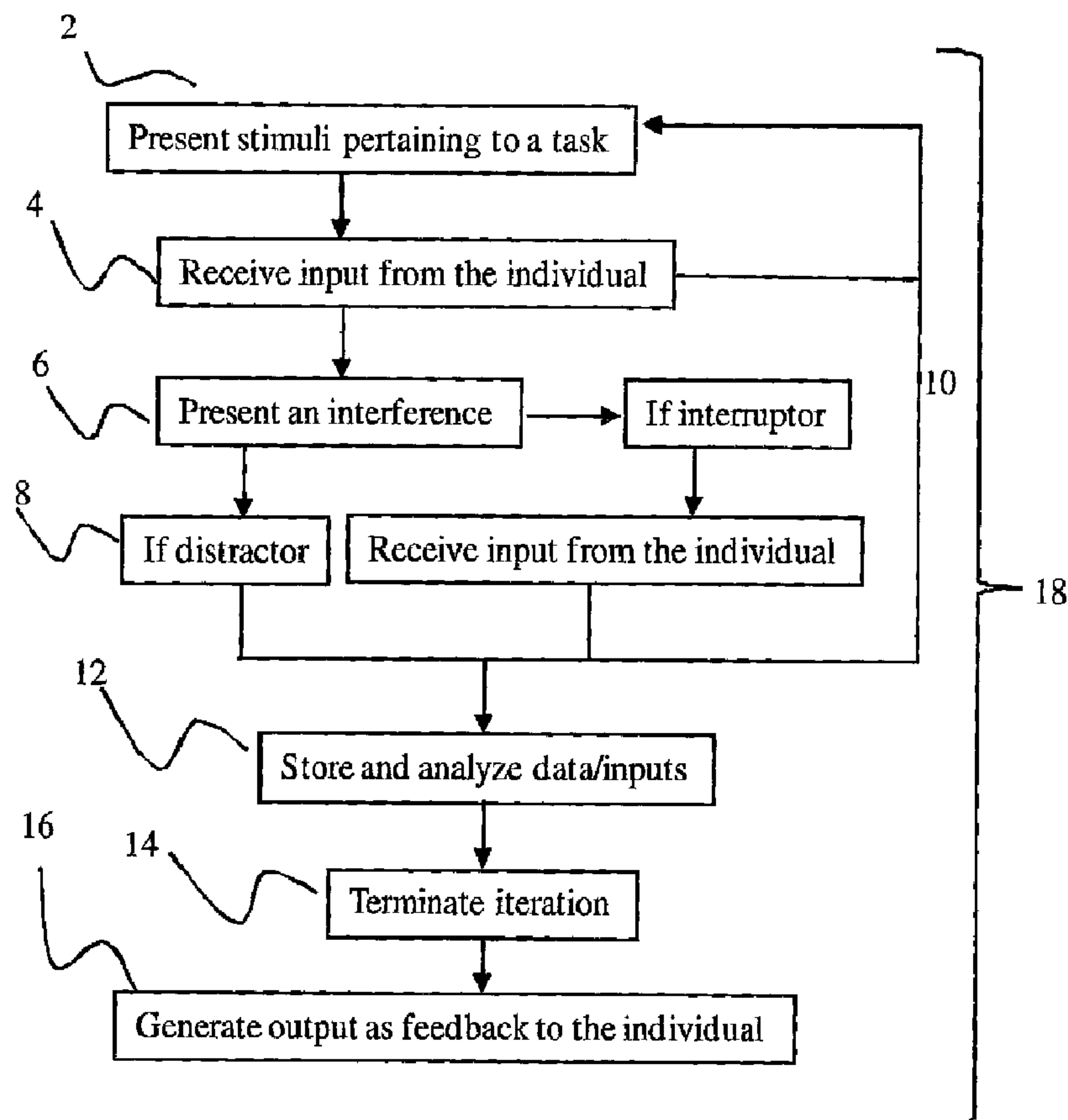
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(54) Title: ENHANCING COGNITION IN THE PRESENCE OF DISTRACTION AND/OR INTERRUPTION



(57) Abrégé/Abstract:

The present disclosure relates to methods and tools for enhancing cognition in an individual. The methods involve presenting to an individual a task to be performed, presenting to the individual an interference, and receiving inputs from the individual. Where the

(57) **Abrégé(suite)/Abstract(continued):**

interference is a distraction, the individual is to ignore the interference. Where the interference is an interruptor, the individual is instructed to respond to the interruptor as a secondary task and is said to be multitasking. Inputs are then also received from the individual pertaining to this secondary task. The methods encompass iterations of these presentating steps and receiving of the input, and generation of analysis and/or feedback to the individual. The methods can further include conducting an analysis and/or generating feedback to the individual. The analysis can include a comparison of the performances with or without each type of interference.

ENHANCING COGNITION IN THE PRESENCE OF DISTRACTION AND/OR INTERRUPTION

ABSTRACT

[00154] The present disclosure relates to methods and tools for enhancing cognition in an individual. The methods involve presenting to an individual a task to be performed, presenting to the individual an interference, and receiving inputs from the individual. Where the interference is a distraction, the individual is to ignore the interference. Where the interference is an interruptor, the individual is instructed to respond to the interruptor as a secondary task and is said to be multi-tasking. Inputs are then also received from the individual pertaining to this secondary task. The methods encompass iterations of these presenting steps and receiving of the input, and generation of analysis and/or feedback to the individual. The methods can further include conducting an analysis and/or generating feedback to the individual. The analysis can include a comparison of the performances with or without each type of interference.

ENHANCING COGNITION IN THE PRESENCE OF DISTRACTION AND/OR INTERRUPTION

INTRODUCTION

[0001] Cognitive decline is a near-universal aspect of normal aging. Some deficits are related to processing of auditory and visual data, for example, and the command of motor functions while in an environment with challenging (noisy, time-limited, attentionally-demanding) conditions.

[0002] One deficit that distinguishes the young from the old brain is the ability to maintain working memory in the presence of interrupting and distracting stimuli. Other deficits can involve the ability to multi-task and concentrate on performing a task in the presence of distractions.

[0003] Accordingly, methods and tools for enhancing cognition are needed. The present disclosure provides methods and tools for improving the cognitive ability that may find use in aging individuals, any individuals suffering from cognitive impairment, or healthy individuals wishing to enhance their cognitive abilities.

SUMMARY

[0004] The present disclosure relates to methods and tools for enhancing cognition in an individual. The training methods involve presenting to an individual a task to be performed, presenting to the individual an interference, and receiving inputs from the individual. Where the interference is a distraction, the individual is to ignore the interference. Where the interference is an interruptor, the individual is instructed to respond to the interruptor as a secondary task and is said to be multi-tasking. Inputs are then also received from the individual pertaining to this secondary task. The methods encompass iterations of these presenting steps and receiving of the input. The methods can further include conducting an analysis and/or generating feedback to the individual. The analysis can include a comparison of the performances with or without each type of interference. Diagnostic methods are also provided herein and are used to assess cognitive ability of an individual independent of or in combination of the training methods disclosed herein.

BRIEF DESCRIPTION OF FIGURES

[0005] **Figure 1.** Panel A, Pictorial representations of certain categories of tasks and stimuli for an embodiment of the present disclosure. Panel B, Pictorial representations: a single task involving target discrimination without interference (left); a visual-motor tracking without interference (middle); and multi-tasking involving both target discrimination and visual-motor tracking (right).

[0006] **Figure 2.** Pictorial representations of various combinations of tasks and different interferences.

[0007] **Figure 3.** A graph representing behavioral assessment of experimental subjects who participated in the tasks and/or interferences represented in Figure 2.

[0008] **Figure 4.** A graph showing the impact on target discrimination abilities of distractors and interruptors (multitasking) in adults across the lifespan (left). A graph representing the impact on visuomotor tracking abilities of distractors and interruptors (multitasking) in adults across the lifespan (right).

[0009] **Figure 5.** A graph showing tracking performance in the setting of interruption for younger adults (dark line) and older adults (gray line) across 12 training sessions (left). A graph showing discrimination performance in the setting of interruption for younger adults (dark line) and older adults (gray line) across 12 training sessions (right).

[0010] **Figure 6.** Pre- and post-training performance of target detection in the presence of distractors (left: distraction costs) or in the presence of interruptors (middle: multitasking costs). Pre- and post-training performance of visuomotor tracking in the presence of interruptors (right: multitasking costs). Each line represents an experimental subject (younger= black; older= gray).

[0011] **Figure 7.** A schematic illustrating certain steps that can be carried out before and/or after a training session.

[0012] **Figure 8.** A schematic illustrating steps of an embodiment of the methods of the present disclosure.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0013] The present disclosure relates to methods for enhancing cognition in an individual. The methods involve presenting to an individual a task to be performed, presenting to the individual an interference, and receiving inputs from the individual. Where the interference is a distraction, the individual is to ignore the interference. Where the interference is an interruptor, the individual is instructed to respond to the interruptor as a secondary task and is said to be multi-tasking.

[0014] The present disclosure is based in part on the recognition that the distraction and multi-tasking (interruption) aspects of interference are separable and can be separately trained. The present disclosure provides methods and systems that provide for separately evaluating the ability to resist distraction and the ability to multi-task, and that provide for separately training the ability to resist negative effects of distraction and enhancing the ability to multi-task.

[0015] Before the present invention and specific exemplary embodiments of the invention are described, it is to be understood that this invention is not limited to particular embodiments described, as such may, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting, since the scope of the present invention will be limited only by the appended claims.

[0016] Where a range of values is provided, it is understood that each intervening value, to the tenth of the unit of the lower limit unless the context clearly dictates otherwise, between the upper and lower limit of that range and any other stated or intervening value in that stated range is encompassed within the invention. The upper and lower limits of these smaller ranges may independently be included in the smaller ranges is also encompassed within the invention, subject to any specifically excluded limit in the stated range. Where the stated range includes one or both of the limits, ranges excluding either both of those included limits are also included in the invention.

[0017] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials similar or equivalent to those described herein can also be used in the practice or testing of the present invention, exemplary methods and materials are now described. All publications mentioned herein are incorporated herein by reference to disclose and describe the methods and/or materials in connection with which the publications are cited.

[0018] It must be noted that as used herein and in the appended claims, the singular forms “a”, “an,” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a stimulus” includes a plurality of such stimuli and reference to “the signal” includes reference to one or more signals and equivalents thereof known to those skilled in the art, and so forth.

[0019] The publications discussed herein are provided solely for their disclosure prior to the filing date of the present application. Nothing herein is to be construed as an admission that the present invention is not entitled to antedate such publication by virtue of prior invention. Further, the dates of publication provided may differ from the actual publication dates which may need to be independently confirmed.

DEFINITIONS

[0020] When describing the methods and compositions of the present disclosure, the following terms have the following meanings unless otherwise indicated.

[0021] The term “cognition”, as used herein, refers to the speed, accuracy and reliability of processing of information in the service of perception, attention and/or memory.

[0022] As used herein, the term "attention" refers to the facilitation of a target and/or suppression of a non-target over a given spatial extent, object-specific area or time window (i.e., selective attention). One aspect of attention is the ability to sustain over time (i.e., sustained attention).

[0023] “Targets,” as used herein, may be both concrete (e.g., a visual focal point such as a person or sign, or an auditory focal point such as a tone or conversation) as well as abstract (e.g., a concept in one’s thought process such as an idea or memory or representation of an event).

[0024] The term “memory” refers to the ability of an individual to learn and retain information either in the long term or the short term.

[0025] The term “perception” refers to the ability of an individual to receive and process stimuli (e.g. discrimination of important data).

[0026] The term “gap” or “inter-stimulus-interval (ISI)”, refers to a specified amount of time between ceasing presentation of a stimulus and presenting a next stimulus in a sequence. For example, a secondary stimulus in the methods of the present disclosure can be presented repeatedly in a sequence with a gap of 2 seconds.

[0027] The term “target stimulus”, as used herein, refers to a stimulus that is arbitrarily chosen by the method or device to be the focus point among a group of different stimuli presented to an individual. An individual is instructed as to the one or more properties that distinguish the target stimulus from the non-target stimulus. The target stimulus differs in at least one property from a non-target stimulus.

[0028] As used herein, the term “non-target stimulus” refers to a stimulus that is not the focus point due to a difference in at least one or more different properties. A non-target stimulus differs from a target stimulus but is not necessarily the same as another non-target stimulus.

[0029] The term “task” refers to a goal and/or objective to be accomplished by an individual who provides a response to a particular stimulus. For example, the individual would have been instructed to perform a specific goal. A “task” can often refer to the main goal that an individual is instructed to perform in the presence or absence of interference.

[0030] The term “interference”, as used herein, refers to a distraction or an interruptor that is presented to an individual when the individual is engaged in performing a task. An interference is a “distractor” or “distraction” if the individual is instructed to ignore the interference. Where the interference is a stimulus to which the individual is instructed to respond, the interference is referred to herein as an “interruptor” or an “interruption”. Performing a task in the presence of an interruptor causes the individual to carry out both a primary task and a secondary task. As such, the individual is said to be multi-tasking in the presence of an interruptor.

Methods

[0031] The methods of the present disclosure enhance cognition by training an individual to perform a task in the presence of interference. Referring to Figure 8, the present methods involves the steps of presenting 2 stimuli pertaining to a task, receiving 4 a first input from the individual, presenting an interference 6, optionally receiving a second input 8, if the interference is an interruptor, and repeating 10 the aforementioned presenting and receiving steps. The method can further encompass storing and analyzing the inputs to evaluate and compare the performances of the

individual in the presence or absence of an interference and in the presence of a distraction versus an interruption.

[0032] The individual being trained by the subject method has been instructed with respect to the presented stimulus in the following ways. In response to stimuli pertaining to a task, the individual has been instructed to perform a primary task. As for stimulus that is an interference, if the interference is an interruptor, the individual has been instructed to respond to the interruptor by performing a secondary task. As such, where the interference is an interruptor, a secondary input is received from said individual in step 8. If the interference is a distractor, the individual is instructed to not attend to the distractor and no input is expected to be received from the individual. These presenting and receiving steps are then reiterated (10) in trial 18 that lasts for a specific duration of time. Where there are two or more trials in a period of time, a group of two or more trials is referred to herein as a training session.

[0033] The stimuli pertaining to a task and those pertaining to the interference are presented concurrently or sequentially to the individual. In most instances, the task is continuously engaging the individual and hence, the interference occurs concurrently with the task. However, the interference can be applied at the end of the task or at interim times during the task (e.g., jittered in time to the onset of task engagement) so as to modulate the degree of interference. The interference can be presented to the individual either as a distractor or an interruptor. As noted above, a distractor requires no response from the individual but an interruptor does.

[0034] The method further involves storing and analyzing the received inputs in step 12 and generating an output in step 16. Analysis and output can take many forms and are discussed in more detail below. Briefly, the analysis evaluates the performance of the individual based on the accuracy of the output in the context of different types of interference (e.g., distraction v. interruption) and/or in the absence of interference.

[0035] The present methods are presented to an individual in two or more trials, with an inter-trial interval in between each trial. The difficulty level in each trial can be dependent on the performance of the individual in the previous trial. If the number of correct inputs in a previous trial reaches a specific threshold, the subsequent trial has a higher difficulty level than the previous trial. However, if the number of correct inputs is below the threshold in the previous trial, the subsequent trial would have a lower difficulty level than the previous trial. Alternatively, the difficulty level can also be designed in a step-wise and/or in a peaks and valley fashion. Further details are discussed below.

Task and interference

A task refers to a goal and/or objective to be accomplished by an individual who provides a response to a particular stimulus. An example of a task is work in which the individual pays attention to the stimulus presented, processes the information of the stimulus, and responds as instructed.

Certain tasks include detection task, target discrimination task, tracking task, acting on a cue, and other data processing task, such as responding to a question. Detection task requires an individual to respond to an occurrence of a stimulus (e.g. a sound or the appearance of an object on a screen). Target discrimination requires an individual to identify a target stimulus from a non-target. A tracking task can involve tracking a path that changes in direction, or pinpointing a moving target. Other examples of a task include carrying on a conversation, typing/writing, physical fitness (e.g. running, walking, biking), reading, shooting, controlling a character on a screen, playing a sport, formulating a strategic decision, and the like.

[0036] Where the individual is presented only with stimuli that pertain to one task, the individual is said to be performing the task without interference. Where there is interference and the interference is a distractor, the individual performs the task in the presence of the distractor and is instructed not to pay attention to the distractor. For example, the task may be navigating a car on a winding path while colored shapes appear and disappear on the screen above the path intermittently throughout the trial. Since the colored shapes are stimuli that require no response from the individual, the individual is said to be performing the task in the presence of a distractor. Conversely, the task may be a target discrimination task, in which the individual is instructed to press a button in response to a green circle that appears on the screen. A car advancing on a path on its own in the background is then a distraction to the target discrimination task.

[0037] Where the interference is an interruptor, the individual performs the task in the presence of stimuli that do not pertain to the task, and the individual is instructed to respond to the interruptor. For example, the task may be navigating car on a winding path and, if a green circle appears on the top of the screen, the individual is required to press a button. Since green circles, among other colored shapes, are stimuli that require a specific response from the individual, the individual is said to be performing the task in the presence of an interruptor. Since the individual is actually performing two tasks, one task is referred to as the primary and the other is secondary. The interruptor is considered a stimulus that pertains to the secondary task in the methods of the present disclosure. In the presence of an interruptor, the individual can also be described as multi-tasking. Interruption may be similar or different in nature from the task, and may be in the same domain (e.g. presented visually in front of or next to the task focal point) or in an orthogonal domain (e.g. a signal requiring the individual to engage in a different perceptual domain (e.g., visual vs. auditory) or to perform a secondary motor task unrelated to the primary task (e.g., verbal vs. manual), details of such variety are discussed below.

[0038] The type of task and the type of stimulus to be presented as interference can be selected from a variety of stimuli and in any combinations as described below. The performance in a specific type of task and/or the response to a specific type of stimulus is an indication of the cognitive ability related to the specific type. For example, a visuomotor tracking task involves visual and motor

sensory skills, while auditory stimuli can involve speech and/or auditory skill. In a trial or in a training session with two or more trials, the individual may be presented with the same task but different interferences or alternatively, same interference but different tasks. For example, the methods can present tracking as a primary task and target discrimination as a secondary task or vice versa. In another example, the distractor can be either the appearance and disappearance of colored shapes or a series of motion picture frames of a car driving on a road. Any other permutations that involve different sensory stimuli and motor and speech commands of the individuals can be incorporated.

Trial and Session

[0039] The method involves presenting two or more trials to an individual where each trial contains a series of presenting and receiving steps set forth above and as seen in Figure 8. Referring to Figure 8, a trial is the series of steps and iterations represented by **18**, optionally including an outputting step **16**. The length of a trial depends on the number of iterations of presenting and receiving steps and can last for as long as about 10 seconds (s), about 20 s, about 25 s, about 30 s, about 45 s, about 60 s, about 2 minutes, about 3 minutes, about 4 minutes, up to about 5 minutes or more. The length of each trial may be pre-determined or flexible. Where the trial length is flexible, it may be dependent on the length the individual desires. Alternatively, the trial length can be dependent on whether a performance level or a training goal has been reached. The time interval between trials can be referred to herein as “inter-trial” interval. Similarly, inter-trial interval can be pre-determined or dependent on the individual’s liking. For example, where an inter-trial interval is within a 24-hour period, the interval can be about a few seconds, about 10 seconds, about 20 seconds, about 30 seconds, about 1 minute (min), about 5 min, about 15 min, about 30 min, about 45 min, about 1 hour, up to about 3 hours or more.

[0040] As noted above, a training session is a group of trials. A session contains at least two trials and can contain about 4, about 6, about 8, about 10, about 12, about 15, about 20, about 25, about 30, up to about 40 or more trials. For example, a session can contain about 20 trials. The number of trials in a session can depend on the length of each trial, determined by the user or the program administrator. The length of a session can be about 10 min, about 15 min, about 20 min, about 30 min, about 40 min, about 60 min, up to about 90 min or more. For example, a session can be about 60 min long. An individual can undergo two or more sessions and as such, there would be an inter-session interval. An inter-session interval can be flexible and chosen by the individual under training. Alternatively, the interval can be pre-determined by an administrator. Some examples include 15 min, 1 hour, 2 hour, 24 hour, 48 hour, 3 days, etc.

[0041] A group of sessions is referred to herein as a training program. A training program contains at least two sessions over a time period and optionally includes pre-and post-assessment, described elow.

[0042] As seen from the above, an individual being trained by the methods of the present disclosure can follow a variety of routines - training programs. Accordingly, the individual may receive an entire set of trials in a single session, or may receive a trial for a specified number of times each day, a session for a specified number of days, with a specified frequency. In other words, in one training program, the individual may go through a plurality of training sessions with a selected frequency (e.g. 3 training sessions daily) over a period of days or months (e.g. 6 months) to improve cognition.

[0043] One example of a training program is to carry out one-hour session of trials (each trial lasting about 3 min), three times a week, for four weeks. Another example of a training program is to carry out a 3-minute trial for 12 times in a 24-hour period, 3 times a week, for a month. The methods of the present disclosure can also be carried out in an ad-hoc fashion without a specific routine. The trials and sessions may be iterated at will with high regularity (e.g. frequently and/or consistently) or low regularity (e.g. sporadically and/or infrequently).

[0044] As such, the methods of the present disclosure can be carried out in a routine and/or program with a flexible range of inter-session and/or inter-trial intervals. From these examples and based on the above, the length of each trial/session/program, the frequency of trial/session/program in any period of a day, week, month, or year, can be selected based on the needs of the individual.

[0045] As noted above, during any iterations as represented by step 10 in Figure 8, stimuli that are presented can be exclusively auditory, exclusively visual, or a combination of both in a session. Similarly, the task involved may also be exclusively tracking (e.g. visuomotor tracking), exclusively target discrimination, or a combination of different tasks. Also, the motor responses can be manual, verbal, or a combination of different responses. The types of stimuli and tasks may remain the same within one trial, across trials, within one session, or among two or more sessions. Alternatively, the types of stimuli and tasks can also change from trial to trial and/or from session to session within a specific amount of time (e.g. a day, within a week, within a month or more).

[0046] As an example, an interruptor may change across trials or sessions as the type of stimuli to respond. The interruptor can require a motor response in one trial or session, and a word prompt requiring a verbal response in a subsequent trial or session. Such change can occur in response to the performance of the individual on the task, in a random manner, or pre-determined by an administrator. Such change can also occur at the same time a difficulty level is changed or independent of changes in difficulty level. Additionally, the individual can be presented with two or more types of interferences at the same time.

[0047] The methods can also include trials where interference is always absent or where a specific type of interference is continuously present. Similarly, the interference presented can also be exclusively distractors, exclusively interruptors, or a combination of both. Where all the stimuli pertaining to the interference in a trial are exclusively distractors or exclusively interruptors, the

interference in a subsequent trial can be a different type of interference than that presented in a previous trial or a combination. Optionally, the type of interference can also remain the same intra-session (e.g. inter-trial) or inter-session. Accordingly, these and other parameters may be selected to design the methods of the present disclosure.

Difficulty Level

[0048] The difficulty level may change or remain the same inter-trial and/or intra-session. The difficulty level of each trial and/or a series of trials in a session can differ among trials and/or sessions. If an individual achieves a threshold level of success (e.g. a pre-determined percentage of correct responses), the difficulty of the trial may be increased relative to the previous trial. Conversely, if the individual achieves a specified level of failure or fails to achieve a level of success, the difficulty of the trial may remain the same or decrease relative to the previous trial.

[0049] A difficulty level can be increased in a number of following ways. One way is to decrease the window of response, which is the time period between the moment a stimulus is presented and when the input from the individual needs to be received. The individual has this window of time to respond as instructed. Hence, decreasing the inter-stimulus interval, the duration of the stimulus, window of response, or any combinations thereof are ways to increase difficulty.

[0050] In a detection task, one way to increase difficulty is to minimize the difference between the stimulus to be detected and the noise and/or background. In a target discrimination task, one way to increase difficulty is to minimize the difference between non-target stimuli and the target stimuli. Images, graphical elements, or auditory elements, can be morphed so that the target stimulus becomes more and more similar (in physical / semantic attributes) to the non-target stimuli. For example, a target of a green circle is more difficult to distinguish from a green pentagon than from a red square.

[0051] In an example of visuotracking, as in navigating a car on a winding path, the difficulty level can be increased by increasing the speed at which the car is traveling, the degree of turns, frequency of turns, narrowness of the path, etc. Difficulty can also be increased by increasing unpredictability of the path or blurring the visual stimuli (e.g. provide a fog, obstruction on the path, sudden turns, etc.)

[0052] Another way to increase difficulty level is to combine stimuli or tasks that involved different senses (e.g. visual and auditory). Having more than 1, more than 2, more than 3 or more different types of target stimuli in one trial or within a session of trials can significantly increase difficulty. Alternatively, complexity of data processing can also be increased. For example, a task that involves repeating a word in response to a spoken word is less complex than responding to a question. Any one or combinations of these ways to increase difficulty can be used in the methods of the present disclosure.

[0053] The difficulty level can be adjusted as frequently as needed and can also be tailored for a predetermined goal or to the ability of the individual. The individual can start at the lowest difficulty

level for the first training session of each training period or each day, at the difficulty level determined by assessments, previous training sessions, or at the difficulty level of his choosing. The individual may be presented with the same difficulty level sessions until a certain level of success or failure is reached. The difficulty level can also decrease, increase, or remain the same, regardless of the performance of the individual. For example, the training may design to have difficulty levels that change in a step-wise fashion or increases and decreases in peaks and valleys so to provide variety, challenges, or interest to an individual. These pre-designed plans of difficulty levels can be independent, or partially dependent on the performance of the individual.

[0054] The methods can also be specifically tailored to the individual by maintaining around a threshold success rate for the individual. For example, the methods can be tailored to target a constant error rate from an individual (e.g. approximately 80% response accuracy).

Termination

[0055] The steps in the present methods are repeated in a trial and the trials are repeated in a session to achieve a predetermined goal. Sessions are repeated in a period of time to constitute a training program. A predetermined goal may be dependent on the responses of the individual or the length of the training. For example, the goal may be for the individual to undergo trials with a certain frequency for a specific length of time (e.g. a month). Alternatively, a sessions can repeat as many trials as necessary or a program can repeat as many sessions as necessary to train the individual to perform at a certain level, measured by one or more indices, e.g., only true hits and no false positives, a certain percentage of true hits, inputting true hits consecutively for a number of times, or a specified reduction of multitasking or distraction costs, or improvement in another cognitive measure that has been obtained prior to training (such as working memory, long-term memory, task-switching abilities), etc.

[0056] The number of iterations that occur in a trial before termination can be based on a number of factors. One is the performance of the individual, as noted above. The iterations can terminate as see in step 14 in Figure 8 when the individual performs with a high level of percent accuracy for a pre-determined amount of time (e.g. 80% or more). Alternatively, the iterations can terminate to conclude a trial when the individual has committed a number of errors. Another factor is the amount of time for which a particular individual or an average individual can concentrate in performing the task. As for terminating a session, the factors involved in determining the number of trials in a session before termination are similar to those involved in a trial. As an example, the session may terminate regardless of the correctness of the inputs in the various trials after a select duration of time (e.g. about 5 trials, about 10 trials, about 15 trials, about 20 trials, up to about 30 trials, or more).

[0057] As for a training program, a training program, for example, may repeat as many sessions as is necessary for the individual to attain at a level of proficiency in which the car can be navigated in the center of the path at least 80% of the time, while simultaneously responding to the target discrimination task. In a target discrimination task in the setting of distracting auditory stimuli, the training sessions can repeat until the ratio of true positives (hits) to false positives achieves a selected threshold. For example, the training may terminate when true positives/negatives significantly outweigh the false positives/negatives in the last 5 sessions. A combination of the thresholds or factors can be analyzed in an assessment to determine the duration of a training program and when termination should occur. Details of an assessment are discussed below. Alternatively, a training session can be terminated by a program administrator and/or the individual at will.

Before a first session

[0058] The individual may be participating in the methods for the first time. A first time refers to a first participation in his life or a first in an experimental period (e.g. one month). Alternatively, a first time can also refer to an individual participating in the method for the first time of the day.

[0059] It would also be appreciated that the method can encompass a step prior to the first presenting step. Where the method is carried out for the first time for an individual, the method can optionally encompass a thresholding step, an assessment, instruction, and/or demonstration. See Figure 7 as an example of a system containing an assessment step before and after a session or training program.

[0060] A thresholding step includes presenting an individual a task without interference in one or more trials. This thresholding step helps determine how an individual performs the task without interference. One purpose of the thresholding is to determine a difficulty level to carry out an assessment and other steps of the present method. Thresholding to a specific difficulty level can be useful in tailoring the present methods to an individual because each individual can have variable baseline abilities to perform a task without interference (e.g., older adults can perform a variety of tasks at a lower performance level when the task is matched in difficulty). If thresholding is not performed, the presence of an interference can place a different demand on the individual depending on his baseline level. Normalizing each individual to a difficulty level can result in a standardized level of interference that is independent of baseline performance on level on the task.

[0061] A difficulty level to carry out an assessment or other steps of the methods is a level at which the individual performs the task with a pre-determined percentage of accuracy (e.g. 80%). The difficulty level of this task without interference can be first presented at a difficulty level that is a default for a category of individuals (e.g. average for an age range), a lowest level of difficulty, or a level comparable based on the individual's prior assessment. The difficulty levels then can change until the individual performs with a specific level of accuracy. Accordingly, the threshold level can be

personalized to the individual. For example, a threshold level for the first time is a level at which the individual can perform the task without interference with an accuracy of about 60%, about 65%, about 70%, about 75%, about 80%, about 85%, or about 90% or more. After a thresholding step, the method optionally includes an assessment before and/or after a training session or training program. Details of assessment are discussed later below.

[0062] Before the beginning of a training session, the methods can optionally demonstrate the type of task and stimulus to be presented and instruct the users how to input a response prior to running a trial. Instructions can provide an exercise to familiarize the individual with the procedures of receiving the presentation of stimuli and with the procedures of inputting a response. The instruction can include details on the types of responses expected from the individual when presented with the stimulus/task or in the absence of the target stimulus. The response can be a physical action of clicking a button and/or moving a cursor to a correct location on a screen, head movement, finger or hand movement, vocal response, eye movement, foot pedaling, running on a treadmill, jumping, etc. Input or response from an individual received by the methods of the present disclosure involves a voluntary initiation of an action on the part of the individual and excludes measurements that may be obtained from an individual passively. In some embodiments, passive inputs, such as brain waves, such as those obtained in magnetoencephalography, are excluded as an input from an individual in the present disclosure. In other embodiments, the methods can encompass receiving as inputs, both a voluntary action on the part of the individual and one or more passive measurements. Passive measurements include any physiological recording, such as electroencephalograph (EEG)/functional magnetic resonance imaging (fMRI)-style measurements, galvanic response, heart-rate, heart-rate variability, etc.

Response and Feedback

[0063] As noted above, the methods assign an individual a task that involves responding to a series of stimuli. Depending on the task, an individual can respond either vocally or via his or her motor function. For example, in a target discrimination task, the response is to click a certain button when presented with a target stimulus and refrain from clicking the button when presented with a non-target stimulus. Other motor response can include stepping on a foot pedal, moving another part of the body (e.g. nodding), running, jumping, etc. Alternatively, the individual can respond vocally by speaking a word or a phrase when presented with a target stimulus.

[0064] Where the task involves a series of visual stimulus as a motion picture, the individual may be instructed to navigate a moving vehicle (e.g. a car or a bike) or to click on certain moving objects. These types of response may be described as visuomotor tracking and can be performed with a keyboard, joystick, bicycle, treadmill, or other exercise equipment, for example. Similarly, where an

individual tracks an auditory stimulus by clicking in the direction of the source of the sound, the response may be described as auditory-motor tracking.

[0065] Where the task is target discrimination or target detection, the following are types of responses that can be received from the individual. Some examples of real-time outputs are also presented for the corresponding response.

[0066] Hit (true positive): If the individual correctly indicates the presence or absence of one or more target stimuli, the response is considered to be a hit. The response would also have to be received within the window of response. For example, the response could be an input via a user interface into a computer, remotely or locally. When the individual's response is a hit or true positive the individual may receive a feedback or output.

[0067] Non-response (true negative): If the individual correctly refrains from indicating the presence of a target stimulus in a stimulus set, i.e. due to the absence of a target stimulus, the individual's response is a non-response or true negative. The individual may be rewarded an output as described above for true positives.

[0068] False positive (false alarm): if the individual incorrectly identifies that a non-target stimulus as the target, the individual's response is a false positive. In this case, the individual may receive a penalty as an output.

[0069] Miss (false negative): If the individual incorrectly failed to indicate the presence of one or more target stimuli, the individual's response is a false negative within a window of response. The subject may be penalized as described below with a bonus meter reset (where progress toward a bonus is reset to zero or decreased).

[0070] If the response is unclear such that it cannot be categorized by the computer or other tools carrying out the subject method, the response can be categorized into false positive, false negative, or simply as an uncategorized/undetermined response.

[0071] Where the task involves tracking (e.g. visuomotor tracking), such as navigating a car on a winding path. The response can be evaluated as the percent of time the object remains on or near the center of the road (hits) and the percent of time the object encroaches beyond the boundary of the path (misses).

[0072] Where the feedback is generated in response to an input during a trial, the feedback pertains to real-time performance of the individual during a session. Where the stimulus is visual, frame color may change, i.e., the graphical user interface (GUI) may modify the color of the region around the target stimulus or stimulus set to indicate an error. For example, in a task requiring navigation of a vehicle on a winding path, there may be a shape (e.g. a crosshair) that appears above the vehicle that changes color, vibrates, etc., in response to how well the individual is performing. If the vehicle is in the center of the path, a crosshair may be green and steady. If the vehicle encroaches the boundary of the road or go off path, the crosshair may shake or change to a red color.

[0073] Other feedback during a trial may be used as desired, e.g., visual shapes, e.g., an "X" in the corner of a screen, resetting the bonus meter, and so forth. Either an auditory or a visual output may also inform the individual a score that has increased, decreased, or remained the same in the number of points, as an indication of whether the input is correct or not.

[0074] Difficulty levels can also be changed in real-time as feedback. Difficulty can increase or decrease in relation to the performance of the task (e.g., a car becomes more or less sensitive to controller manipulation when there is progress in the performance of a task. The car can also become more or less sensitive to controller manipulation when there is negative progress. Other changes in difficulty level encompass darkening all or partial screen view or brightening or clearing up the visual view. For an auditory stimulus pertaining to the task or interference, similar strategies may be used. These examples and other ways of changing difficulty levels described above can be a mode of feedback to the individual.

[0075] As seen above, the method can generate an output to inform the individual whether or not the input is correct. Both the output and the stimuli can be exclusively auditory or exclusively visual. Alternatively, the output can be auditory if the task involves visual stimuli and vice versa in order to avoid confusion. Some examples of outputs are discussed below.

[0076] After a series of inputs (e.g. after termination of a trial or a session of trials), the methods store and/or analyze the inputs to determine if how well each task is performed. The method can optionally generate an output to inform the individual of the performance level for the completed training session. The output may be auditory feedback, such as sound (e.g., a "thunk" or silence for a decrease in performance and a "ding" for an increase in performance level relative to a previous trial) or visual feedback (e.g., a graphical indication). Output can include bonus meter advances, and after five non-responses in a row, for example, visual feedback (e.g., a graphical success indication, progression of levels, such as a displayed "checkmark"), lack of point addition or subtraction of points and/or addition of points..

[0077] The output at the end of a complete trial or a training session can further include an in-depth analysis. The analysis consolidates all or part of the indices measuring the performance of the individual. The data used for the analysis may be derived from the training session itself and/or a post-training assessment step, details of which are discussed below.

Pre-training and post-training assessment

[0078] As noted above, methods of the present disclosure can further include a pre-training assessment and a post-training assessment. The methods can also include one or more assessments intermittently throughout the training in order to provide feedbacks as discussed above (e.g. inter-trial or inter-session).

[0079] Similarly to other steps of the methods described above, an assessment can include presenting a task and optionally an interference to an individual, and evaluating the performance of the individual with and/or without the interference. An assessment is different from a training session in that it does not seek to train the individual. Unlike a training session, the difficulty level from trial to trial in an assessment does not change or adapt to the performance of the individual. Rather, the difficulty level in an assessment trial remains the same (e.g. at the difficulty level determined by the thresholding step). The purpose of the assessment is mainly to evaluate the performance of the individual.

[0080] As a specific example, an assessment can include presenting a target discrimination task in the presence or absence of an interference, such as an interruptor or distractor (e.g. car driving autopilot in the background). An assessment also may present a trial including a visuomotor tracking task in the presence of an interruptor or a distractor. An assessment can contain about 2, about 3, about 4, about 5, about 6, about 8, up to about 10 or more trials. Each trial can differ in the task and/or interference presented. An assessment can include a series of trials that last about 20 min, about 30 min, about 40 min, about 50 min, up to about 60 min or more. For example, an assessment may be a series of five different trials conducted within a 60 min period.

[0081] Referring to Figure 7, the assessment described above can be conducted before and/or after a training session or training program. The steps involved in a post-training assessment are the same as those of a pre-training assessment described above, except that in a pre-training assessment, the data are used to determine the ability and/or performance of an individual prior to training. In a post-training session, however, the data analyzed may include data collected not just in the assessments themselves but also during the training program. The analysis also reflects the performance and ability of the individual after training. In other words, post-training assessment can compare the performance of the individual post-training to that prior to training and assess the impact of training on the cognitive ability of the individual. See Figure 5 for example.

[0082] Where the methods of the present disclosure include a post-training assessment step, a variety of data and analysis can be carried out. The data analyzed may include percent accuracy, hits, and/or misses in the latest completed trial or training session. Another index that can be used to measure performance is the amount time the individual takes to respond after the presentation of a target stimulus. Other indices can include, for example, reaction time, response variance, correct hits, omission errors, false alarms, learning rate, and/or performance threshold, etc. The performance can be further analyzed to compare the effects of two different types of interference (e.g. distraction or interruptor) on the performances of the various tasks. Some comparisons can include performance without interference, performance with distraction, and performance with interruption. The cost of each type of interference (e.g. distraction cost and interruptor/multi-tasking cost) on the performance level of a task is analyzed and reported to the individual. For example, an individual can be informed

that his performance level decreased 10% in the presence of a visual distractor (distraction cost), but decreased 20% in the presence of an interruptor (e.g. when he is multi-tasking) (multitasking cost). As such, the cost of the distractor is half as much the cost of multi-tasking.

[0083] Any or all of the analyses and data may be presented to an individual in a report listing the task, the specific type of interference and their corresponding cost to each task. The methods can also generate a report with a graph showing any previous session or series of session in comparison to the latest session. The analysis may further categorize performance based on the type of stimuli and sensory functions involved in the tasks or interference. Additionally, the analysis may present the performance measures relative to another group (e.g., how a particular individual compared to others in his age range). These and other analyses can be reported directly on a display screen, stored in a database, and communicated audibly and/or via electronic mail.

[0084] As noted above, aside from determining the correctness or incorrectness of the individual's response, the method can also analyze, store, and output the reaction time for the response and/or any statistical measures for the individual's performance (e.g. percentage of correct or incorrect response in the last number of trials, over a specified duration of time, or specific for a type of non-target and/or target stimuli, a specific type of task, etc.). In addition to what is discussed above, other means of assessing the cognitive abilities known in the art may also be employed as a post-training assessment or part thereof. Some examples of assessment of cognitive abilities known in the art include those for intelligence (e.g. Kohs block, Miller Analogies Test, Wechsler Adult Intelligence, Wonderlic Test, or other IQ-related test), for cognitive development (e.g. Knox Cubes, language aptitude, Porteus Maze Test, and the like), psychiatric/personality test (e.g. Myer-Briggs, etc.), and memory test (e.g. short-term, long-term, working, semantic, etc.).

[0085] The one or more different outputs of described above may or may not be presented to the individual after each trial. When and what output is generated can also be pre-determined by the individual and/or the operator of the training program.

[0086] In addition to providing an evaluation on the performance of the individual and the impact of a training, assessments can also be used to guide an ongoing training program. Periodic assessments over time can be used to determine if there is need to alter or maintain a particular strategy for training e.g. maintaining/changing a task, an interference, a particular type of stimuli, means of input, etc. For example, an assessment may inform a program administrator that the individual in need for a "booster" training. Such assessment can be carried out inter-trial, inter-session, or in between administering two or more training programs. See Figure 7 as an example where multiple arrows reflect the flexibility of inserting assessment wherever appropriate as part of an ongoing process. The combination of the iterative nature of the training and assessment is an example of a system approach to the methods of the present disclosure.

[0087] The methods of the present disclosure may also be combined with other methods that aim to enhance cognition or methods that improve physical fitness, and overall wellness. For example, the training of the methods of the present disclosure can alternate or can be employed concurrently with training of a second method to result in a combination training regimen. One example is to require inputs from individual that involve physical exercise, such as running on a treadmill, bicycling, using a device with motion/position sensor technology (e.g. Sony Wii Fit, Playstation Move, or Xbox Kinect), and the like. The physical exercise as input may be unrelated to the task or interference presented to the individual. Alternatively, the physical exercise may be the means by which the input is received to perform a task.

[0088] The method may be designed to be presented to an individual in a form of game or challenge, in which instructions to an individual include game objectives and individual's input are scored. For example, a correct response increases points whereas the score remains unchanged or decreased in points if the response is incorrect.

[0089] The methods of the present disclosure encompass the addition of engaging game elements that are integrated with the training session. These game elements confer substantial benefits to the user or the training program. One benefit is that the game context may encourage the user to engage more attentional resources to task, which can be critical for enhancing cognition. Additionally, the game context can provide incentives for a user to pay attention and/or complete the training. In other words, the interest and goal orientation created by the game context provide incentive to continue training for longer periods of time than would generally be supported by the less engaging training task on its own. Game specific features that can increase incentive and interest of an individual may include but not limited to bonus points, in-game reward or penalty, such as a graphical or auditory representation thereof, rewards or penalties that scale with difficulty level or time spent, real life rewards, etc. Additional game elements to enhance engagement are common to those skilled in the art of video gaming, board games, cognitive paradigms, fitness/sports instruction, and educational programs.

Diagnostics

[0090] As noted above, the method optionally includes a pre-training assessment and/or a post-training assessment. In addition to being employed to evaluate an individual for training purposes, the assessment can be used alone or in combination with other regimen (e.g. physical wellness or medical treatment) for diagnosis purposes.

[0091] Steps of an assessment as described above provide a measure to evaluate the effectiveness of training. As described above and in the example section below (of this Figure 6), an individual's distraction and multitasking costs can be measured and compared to those prior to training.

[0092] In dependent of the training, assessment can also be used in other contexts, such as to assess an individual for its cognitive ability to diagnose disease or prognosis. Cognitive ability (e.g. susceptibility to interference, working memory, multi-tasking ability, and the like) provides an important index in diagnosing diseases related to cognitive impairment (e.g. Alzheimer's disease), side-effects of drug, surgery, or other medical intervention, prognosis, etc. Target populations for training and/or diagnostics are described in greater detail below.

Stimulus

[0093] As noted above, the method involves presenting to an individual a task in addition to an interference. A task involves presenting a stimulus that requires a response from the individual as an input. An interference involve presenting one or more stimuli that are to be ignored (i.e. a distractor) or that require a response (i.e. an interruptor).

[0094] A stimulus employed by the present methods may be visual or auditory, for example. A task further requires a response from an individual that may require data processing and commands of certain senses. Below are descriptions of some examples of stimuli that can be used in the present methods and the senses involved in generating a response in a task.

Visual

[0095] A stimulus presented to an individual can be visual. A visual stimulus is made up of electromagnetic waves in the visible light spectrum and may be characterized by, for example: brightness, color, shape, surface texture, orientations (e.g. grating), location in a visual field, orthographic (e.g. textual), quantity, or motions, as well as properties of these characteristics. Each stimulus may also be referred herein as a graphical element.

[0096] Each graphical element may be presented with a specific duration to an individual, e.g. for a fraction of a second, for a second or for a length between about 1 and about 2 seconds or for up to about 2 seconds or more. For example, a visual stimulus may be a geometric shape of a circle, or a red cone, the number "5", or the like. Another example of a visual stimulus can be a specific human face, face of a specific age range, face of different ethnicities, or any parametric variations thereof.

[0097] A visual stimulus can also be an image that is rich so as to contain multiple shapes, colors, textures, etc, as seen in a photograph, digitally-generated picture, or moving video such as in current movies or video games. The image may be a vehicle advancing on a road, in which the road can be of various shapes and width. A series of consecutive images can be presented so the individual would perceive the visual stimuli in a form of a motion picture. In the example of an image of a vehicle on a road, a series of visual stimuli can present to an individual a vehicle that is advancing on the road.

[0098] Where the visual stimuli are employed in a task, the task can be target discrimination for example. The task may involve instructing an individual to respond to a green circle whenever a green circle appears on the screen. Where other shapes or other colored circles are presented (e.g. green pentagon), the individual is not to respond. How an individual may respond in a task is discussed later below. A target visual stimulus can also be a face of a child while the non-target stimulus is a face of an adult. As another example, a target visual stimulus can also be a visual image of a first animal (e.g., non-human animal) of a certain species while the non-target visual stimulus can be an animal of a species different from the first animal. A target visual stimulus may differ from a non-target visual stimulus in one or more of any properties inferred from herein.

[0099] The visual stimuli can also be presented in another type of discrimination task. The individual is presented a series of visual graphical elements and is instructed to respond to a target graphical element that does not belong in the same category as other non-target graphical elements in the series. In another similar task, the individual can be instructed to identify a part that does not appear in a correct location or orientation as other parts of an object that are presented to the individual in a series.

[00100] Where the task involves images presented as a motion picture, the task can involve visuomotor control. The individual would be instructed to control a moving object in an environment in which the colors, shapes, or any properties discussed above are changing. One example includes navigating a moving vehicle on a winding path or on a path with obstructions. Other examples can include clicking on specific objects that appear or move.

Auditory

[00101] A stimulus presented to an individual can be auditory. An auditory stimulus refers to a sound and may be characterized by, for example: frequency, loudness (i.e. intensity), timbre, or any parametric combination of these or any other sound features. The duration of time an auditory stimulus is presented to an individual can be varied. For example, an auditory stimulus may be presented to an individual, e.g. for a fraction of a second (such as about 40 milliseconds (ms), about 50 ms, about 60 ms, about 70 ms or more), for a second or for a length between about 1 and about 2

seconds or for up to about 2 seconds or more. An example of a duration of an auditory stimulus presentation is about 100 ms.

[00102] A stimulus can also be spectrally-complex stimuli like vowels, phonemes, syllables, words, questions, or statements. A stimulus can also be presented by a voice and as such characterized by the presenting voice (e.g. call of a specific bird). The auditory stimulus can also be characterized by a waveform that is defined by amplitude (i.e. intensity or loudness), frequency, or any other sinusoidal properties.

[00103] Similarly to the visual stimulus discussed above in which a series of visual stimulus is perceived as a motion picture, a series of auditory stimulus can be perceived by the individual as a statement, a song, a narration, etc.

[00104] Where the task involves target discrimination, a target auditory stimulus can differ from a non-target auditory stimulus in any one or more of the characteristics, such as frequency, loudness, or timbre, as well as properties of these characteristics. For example, if they differ in frequency, the difference in frequency may be measured in hertz or octave. Hertz (Hz) measures the numbers of cycle per second in the sound wave while octave represents frequency as pitch. The frequency difference between a non-target auditory stimulus and a target auditory stimulus may be between about 0.01 to about 0.05%, between about 0.05% to about 0.1%, between about 0.1% to about 0.3%, between about 0.3% to about 0.5 %, between about 0.5% to 1%, between about 1% to about 3%, between about 3% to about 6%, up to about 9% or more.

[00105] Where the difference between a non-target auditory stimulus and a target auditory stimulus differs in loudness, the difference can be expressed in sound pressure level (SPL) measured in decibels (dB) above a standard reference level. The standard reference level is about 20 μ Pa. For example, in a target discrimination task, an individual can be instructed to respond to only to a female voice.

[00106] In another task that involves auditory stimulus, the individual can be instructed to answer a question that is asked vocally or to repeat certain words or sounds in response to a spoken auditory stimulus.

[00107] Any of the characteristics of sound described above, and combinations thereof, can be one or more of the ways in which the target auditory stimulus may be used in the present methods.

Combination stimulus

[00108] A combination of stimuli of different sensory systems may be presented to the individual in the methods of the present disclosure. For example, both auditory and visual stimuli may be presented concurrently or in sequence. The series can also present a sequence of auditory and visual stimuli that can be synchronized or unsynchronized. In a discrimination task, a target set can contain either a target auditory or a target visual stimulus or both. For example, a target stimulus may

be a combination of the visual stimulus of a green circle as well as the spoke word “circle” as the auditory stimulus.

Timing of presentation

[00109] During iterations, two or more interferences can be presented and the interference can be presented in a variety of different sequences and timings. Using various sequences and spacings of interference can train the desired effects of the invention in multiple ways, and may have different effects for different users. For example, the interruptors and/or distractors can be presented rapidly, or very sparsely, or in random spacings. Interruptors and distractors may alternate in regular patterns or may vary with a random interval with respect to a previous interference or a stimulus pertaining to a task. As noted above, interference can be presented concurrently or sequentially with a task. For example, an interference can be presented during an interval between stimuli pertaining to a task. Either the individual or the program administrator can control the jitter of the timing between the interference and the task.

[00110] Two or more stimulus pertaining to a task or interference can be presented in a series (e.g. a motion picture or a sentence). A sequence of stimuli presented to an individual with the same or similar inter-stimulus-interval (ISI). Where the sequence of stimuli is presented to an individual with the same ISI, the stimuli are said to be occurring in the same frequency in a session. The ISI of a set can be 3 seconds (s), 2.5 s, 2 s, 1 s, or a fraction of a second, such as about 600 milliseconds (ms), about 500 ms, about 400 ms, about 300 ms, about 200 ms, or about 100 ms or less. Alternatively, the series of stimuli may not have the same ISI and the ISI may be random.

[00111] Where a visual stimulus set is presented as a motion picture, ISI of consecutive images can also be referred as frequency and can be expressed as frames per second (FPS). A motion picture can have a frequency of about 40 Hz, about 45 Hz, about 50 Hz, about 55 Hz, or about 60 Hz, about 70 Hz or more.

[00112] Where there is a discrimination task, the set contains a target stimulus, the set contains at least one target stimulus in the sequence. The percentage of target stimulus can be about 10%, 20%, 40%, 50% or 60% or more of the non-target stimuli presented. The number of target stimuli is less than the number of total stimuli. Alternatively, the percentage of target stimuli can be random. The target stimulus can be presented in a constant frequency or randomy in a series. For example, the target stimuli can have an equal chance to appear at any location in a series of stimuli or consistently every 3 stimuli.

TARGET POPULATION

[00113] Individuals that can use the methods and tools of the present disclosure can be any person, especially those interested in enhancing cognitive abilities. For any of the target populations

described below, diagnostics to assess one's cognitive ability (e.g. impairment or susceptibility to interference) and training are particularly useful applications of the methods of the present disclosure. Individuals that can benefit from the subject methods and tools include but not limited to adults, such as aging adults. For example, the subject methods and tools can be useful for adults that are of any age. For example, adults of about 30 years old, about 40 years old, about 50 years old, about 60 years old, about 70 years old, up to about 80 years old or older may be an individual to the methods of the present disclosure. Measurable deterioration of cognitive abilities in an individual is common as he or she ages. The experience of this decline may exhibit as an occasional oversight in various tasks and/or increasing difficulty in concentration. The decline often progresses to more frequent lapses as one ages in which there is passing difficulty performing tasks requiring extraction of visual or auditory information while multi-tasking or avoiding distractions. Avoiding dangers when driving a car, scanning a crowd for a familiar face, and reading quickly are a few of such examples. Thus, the present invention is particularly useful in individuals of any age desiring to improve their cognitive abilities or ameliorate the rate of decline in cognitive function.

[00114] Such decline typically accelerates at age 50 and older and over subsequent decades, such that these lapses become noticeably more frequent. It is often clinically referred to as "age-related cognitive decline". While often viewed (especially against more serious illnesses, e.g. Alzheimer's disease, Parkinson's disease) as benign, such predictable age-related cognitive decline can severely alter quality of life by making daily tasks arduous.

[00115] Age-related cognitive decline can lead to a more severe condition now known as Mild Cognitive Impairment (MCI), in which sufferers show specific sharp declines in cognitive function relative to their historical lifetime abilities while not meeting the formal clinical criteria for dementia. The subject methods and tools have the potential to reverse and/or prevent the onset of this devastating neurological disorder in humans, such as those suffering or at risk for MCI.

[00116] Aside from age-related cognitive decline, people of all ages who experience or are at risk for cognitive impairment can benefit the subject methods and tools. For example, the present methods are useful for training individuals whose cognitive losses have arisen as a consequence of injury, medical treatments, chronic neurological, psychiatric illness, or of unknown cause. Such cognitive impairment, age-related or not, can be a contributing factor or manifesting symptom of a variety of conditions, including Alzheimer's disease, Parkinson's disease, depression, schizophrenia, vascular dementia, multiple sclerosis, post traumatic stress disorder (PTSD), obsessive-compulsive disorder (OCD), and others. Other cognitive losses can include brain damage attributable to infectious pathogens, medical intervention, alcohol or drugs, etc. Thus, cognitive decline or impairment can be a contributing factor or negative influence on a variety of adverse conditions, and thus the methods of the present disclosure can be useful in combating or diagnosing anxiety, stress, panic, depression, dysphoria, or malaise. Additionally, cognitive decline may result as a secondary symptom from a

variety of disease states that are on the surface unrelated to cognition, but which significantly adversely affect the above-mentioned cognitive processes. Accordingly, individuals experiencing pain or diseases having a significant pain component, insomnia, or adverse effects of disease treatment such as chemotherapy or radiation therapy can also find use in methods of the present disclosure.

[00117] Populations that can benefit from the present methods further encompass those that suffer from attention deficit disorder (e.g. attention deficit hyperactivity disorder (ADHD)). Cognitive losses of developmentally impaired child and adult populations, encompassing general or undiagnosed developmental delays, Autism Spectrum Disorders (ASDs) (e.g. Asperger's), can also be potentially reversed by the subject method.

[00118] For individuals suffering from chronic neurological and psychiatric illness, changes in inhibitory neuron populations, myelination, response slowing, emergent response dis-coordination, degradation of response selectivity in spatial, spectral and temporal detail, and the degradation of the distinctions between background and target stimuli are very similar to the effects of age-related cognitive decline. Accordingly, individuals of any age with profiles of cognitive impairment that parallel those in aging are target populations for the methods and tools of the present disclosure. The individuals can experience substantial 'corrective' neurological changes if trained by the subject methods.

[00119] Additionally, many individuals, though not experiencing a perceptible decline in cognitive function, may desire to increase their current cognitive abilities. One example is to improve the performance of everyday tasks (e.g. multitasking, focus, memory, social skills, such as conversational skills, decision-making abilities, creativity, or reaction times to specific tasks. Another example is to improve general metrics of cognitive ability (e.g. to "enhance IQ"). Since people are susceptible to interference or are exposed to interference in daily life, the present methods also has a utility for training cognitive abilities in those who are not necessarily experiencing a cognitive decline or impairment. Secondary effects dependent on the above mentioned and trained cognitive abilities may also be a target for training using the present invention. Examples include learning, such as learning in a specific subject area (e.g. math or reading), a general ability to learn in the presence of interference, enhancing social interaction, etc.

End-user Products

[00120] The method of the disclosure can be incorporated into a variety of manifestations that deliver the training to an individual, including “products” that would be used by individuals of the target populations. Such products may be provided by a cognitive scientist or researcher, a clinician or other healthcare provider (such as a psychiatrist, psychologist, physician, nurse, or specialist), or without any supervision and simply used by the individual alone.

[00121] The methods can be incorporated into a software or computer program (e.g. a video game). Computers and related products are described further below. The methods of the present disclosure can be the sole focus of the video game, such as a video game centered around driving a car through a winding course while processing various interferences. Alternatively, the method can be incorporated into an existing game, serving as a specific portion of the game but not the primary focus (e.g. one portion in time or space, a goal of a level, or as an intermittent task within or between levels, or as presented sparingly throughout gameplay).

[00122] In another example, the methods are incorporated into experiences, such as a movie, television program, or an application in a social network. Progress or success in carrying out the methods can “unlock” features of this experience, or progress in participation of the separate experience. For example, when watching a movie, the method may appear as a game, and a user that attains a certain level of success can continue the movie. As for a social network experience, success at a certain level may contribute to unlocking certain contacts within the social network.

[00123] Alternatively, the method is incorporated into a non-electronic game that the individual plays, such as a board game, a card game, or an interpersonal/social game. In such a game, interferences may be tangible portions of the game (e.g. a specific type of cards) or may be actions deriving from game rules (e.g. a second gameplayer distracting or interrupting a first gameplayer who is accomplishing the training).

[00124] The method can also be incorporated into a cognitive laboratory-style paradigm or cognitive training task, analogous in substance and execution to those known in the art and practiced by cognitive science researchers, such as the n-back working memory task and the Sustained Attention to Response Task (SART), details of which are known in the art. These and other paradigms may be used for research purposes, or for training of an individual.

[00125] In an additional example, the task in the methods of the present disclosure can be an actual real-world task that is part of the individual’s daily life. The individual may desire training on this particular task. Distractions or interruptions are then administered to the individual via a game, a software, or an interface that at a given frequency during the task. The individual can decide when to do the task that they would desire training on, and then activate the distraction/interruption product employing the methods of the present disclosure. The individual is then being rigorously trained to do the task in the presence of interference. The individual may provide the feedback on success at

completing the task, time to complete the task, or general satisfaction with the product of the task. The feedback from the individual would be an input to the interference interface. As a non-limiting example, a distraction/interruption application can be developed for a mobile device (e.g. iPhone) that includes a variety of distractions and interruptions. A user may, for instance, want to improve their working memory while typing a report for work, and would therefore activate the distraction/interruption application when commencing the work report. The distraction/interruption application receives and registers input from responses and non-responses, as well as updates on the individual's progress on his task. The analysis can be reported either from an objective (e.g. percent completed) or subjective (e.g. satisfaction with progress) measure. The distraction/interruption application can increase difficulty on the distraction/interruption stimuli as described above, as well as increase "difficulty" on the task by, for example, requiring a faster pace (in % of task completed per time).

[00126] The products provided herein also encompass diagnostics methods described above. Any of the products described above can be used as an "assessment" or "diagnostic" in which an individual engages for a defined period of time on the method. An evaluator then determines that individual's cognitive impairment or susceptibility to interferences. Any types of interference described herein can be applied in a product to hone in on the exact deficit or susceptibility of that individual. This diagnostic product can generate a report of one's deficit features, and optionally, a recommended training regimen to enhancement of those corresponding skills.

COMPUTER SYSTEM AND TOOLS

[00127] The present disclosure provides computer program products that, when executed on a programmable computer, can carry out the methods of the present disclosure. The subject matter described herein may be embodied in systems, apparatus, methods, and/or articles depending on the desired configuration. In particular, various implementations of the subject methods described herein may be realized in digital electronic circuitry, integrated circuitry, specially designed ASICs (application specific integrated circuits), computer hardware, firmware, software, and/or combinations thereof. These various implementations may include implementation in one or more computer programs that are executable and/or interpretable on a programmable system including at least one programmable processor, which may be special or general purpose, coupled to receive data and instructions from, and to transmit data and instructions to, a storage system, at least one input device (e.g. video camera, microphone, joystick, keyboard, and/or mouse), and at least one output device (e.g. speaker, headphones, and/or monitor display). Other input devices include those employed in physical exercise, such as a treadmill, elliptical, bicycle, steppers, motion/position sensor remotes (e.g. Wii), etc.

[00128] These computer programs (also known as programs, software, software applications, applications, components, or code) include machine instructions for a programmable processor, and may be implemented in a high-level procedural and/or object-oriented programming language, and/or in assembly/machine language. As used herein, the term "machine-readable medium" refers to any computer program product, apparatus and/or device (e.g., magnetic discs, optical disks, memory, Programmable Logic Devices (PLDs)) used to provide machine instructions and/or data to a programmable processor, including a machine-readable medium that receives machine instructions as a machine-readable signal.

[00129] Similarly, systems of the present disclose may also include a processor, such as CPUs, and a memory coupled to the processor. The system further includes a user interface (e.g. GUI) and one or more communication buses for interconnecting these components. The user interface includes at least one or more actuators (e.g. display or speakers) and one or more sensors, and may also include one or more feedback devices. For example, speakers or headphones may provide auditory prompting and feedback to the individual during execution of the computer program. Input devices such as a joystick, a mouse, a keyboard, or a device with motion/position sensor technology (e.g. Wii remote) allow the individual to navigate the computer program, and to select particular responses after visual or auditory prompting by the computer program. Where the methods involve physical exercise as an input or part of the regimen, the input can further employ exercise machines, such as a treadmill, bicycle, stepper, Wii Fit, and the like.

[00130] The memory may include one or more programs that cause the processor to perform one or more of the operations of the methods described herein. Memory may include high speed random access memory and may also include non-volatile memory, such as one or more magnetic disk storage devices. Memory may include mass storage that is remotely located from the central processing unit(s). The memory stores an operating system (e.g., Microsoft Windows, Linux or UNIX), an application module, and may optionally store a network communication module. Although a number of different computer platforms are applicable to the present disclosure, embodiments of the present disclosure execute on either IBM compatible computers or Apple computers, or similarly configured computing devices such as set top boxes, handheld devices (e.g. personal digital assistants (PDAs), mobile devices), gaming consoles, etc.

[00131] As noted above, the system may optionally include one or more networks or other communications interfaces, such as a network interface for conveying testing or training results to another system or device. The computer network contains computers, similar to the one described above, connected to a server. The connection between the computers and the server can be made via a local area network (LAN), a wide area network (WAN), or via modem connections, directly or through the Internet. A printer may also be connected to the computer in a network to illustrate that an individual can print out reports associated with the computer program of the present disclosure. The

computer network allows information such as test scores, game statistics, and other data pertaining to an individual's performance to flow from one computer to another, e.g. a server. Data pertaining to an individual's performance can include, for example, reaction time, response variance, correct hits, omission errors, false alarms, learning rate, and/or performance threshold, etc. An administrator can review the information and can then download configuration and data pertaining to a particular individual, back to the individual's computer. Alternatively, or additionally, the server may execute the computer program, and the individual may interact with the program via the individual's computer, e.g., in a client/server relationship.

[00132] As noted above, the individual may perform the training exercise via a graphical user interface (GUI), whereby graphical elements and/or sounds are presented to the individual and whereby the individual may provide responses. For example, the GUI may include the visual field within which various images, e.g., target stimulus, may be displayed in a sequence to the individual, as well as various on-screen buttons or controls whereby the individual may interact with the training exercise. For example, the display may provide a start button in which the individual may press (e.g., click on) to begin or resume a training session. Additional GUI elements may also be provided, e.g., for indicating various aspects of the individual's progress or status with respect to the exercise or task, such as the difficulty level of the current training block. Examples include a bonus meter (or equivalent), which may indicate the number of correct responses in a row, a graphical element that flashes, a program that plays music, and/or award bonus points, when some specified number, e.g., 5, of correct responses is attained.

[00133] The application module executing the present method may include one or more of the following: a) a stimuli generation control program, module or instructions, for generating series of stimuli, as described above for the present method; b) an actuator or display control program, module, or instructions, for producing or presenting the stimuli to an individual; c) a sensor control program, module or instructions for receiving input by extracting raw data in the sensor signals indicative of the individual's response; the sensor control program, module or instructions may also include instructions for controlling operation of the one or more sensors; d) a measurement analysis program, module or instructions, for analyzing the individual's responses to produce measurements and analyses, as discussed above; and e) a feedback program, module or instructions, for generating feedback signals as output for presentation to the individual via the one or more actuators or feedback devices.

[00134] The application module may furthermore store data, which includes the measurement data for an individual, and optionally may also include analysis results and the like. The application module may also store data derived from theoretical users or actual users other than the individual. Such data may be used as normative data from one or more control groups of individuals, and optionally may also include analysis results, and the like, based on the measurement data from the one

or more control groups. Any of the programs described above may be stored or executed from more than one locations, e.g. more than one computer readable medium. For example, the stimuli generation program may be executed remotely via a network while the measurement analysis program may be stored and/or executed locally.

[00135] As noted above, the methods of the present disclosure can be employed as computer-based exercises and tasks in order to improve an individual's cognition, e.g., the efficiency and capacity of performing a task in the presence of an interference. Although a few variations have been described in detail above, other modifications or additions are possible. In particular, further features and/or variations may be provided in addition to those set forth herein. For example, the implementations described above may be directed to various combinations and subcombinations of the disclosed features and/or combinations and subcombinations of several further features disclosed above. In addition, the logic flow depicted in the accompanying figures and/or described herein does not require the particular order shown, or sequential order, to achieve desirable results.

[00136] The following examples further illustrate the present invention and should not be construed as in any way limiting its scope.

EXAMPLES

[00137] It is understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims. All publications, patents, and patent applications cited herein are hereby incorporated by reference in their entirety for all purposes.

EXAMPLE 1 EXPERIMENTAL SETUP FOR ASSESSMENT

[00138] The study involved adults at various ages (recruited into 4 randomized study groups: 1) single-task training, 2) multitasking training, 3) distraction training, and 3) no-contact control (NCC). Training groups engaged in 12 hours of home training and 6 laboratory visits: 1) neuropsychological testing, 2 & 3) pre- and post-training cognitive assessment, 4 & 5) pre- and post-training neural assessment, and 6) six-month follow-up cognitive evaluation. NCC group engages in 1) neuropsychological testing, 2 & 3) pre- and post- no-contact interval cognitive assessment, 4 & 5) pre- and neural assessment.

[00139] To evaluate interference abilities pre- and post-training, participants engage in five experimental tasks from three categories:

- *single tasks* (1) target discrimination- “shoot”, (2) visuomotor tracking- “drive”;

- *distraction tasks* (3) target discrimination while passively exposed to tracking task- “shoot with road” (4) visuomotor tracking while passively exposed to target discrimination task- “drive with signs”); and
- *interruption/multitasking* (5) simultaneous target discrimination and visuomotor tracking- “shoot with road”).

There are three, 5-minute blocks of each task, presented in a pseudo-randomized order across participants.

[00140] 1) Single task: Target discrimination (“shoot”). In this task, a “sign” appears on a black background, 2.5 degrees above a central fixation cross at a randomized SOA (stimulus onset asynchrony: 2, 2.5, and 3 sec). An example of a screen shot is shown left of panel A in Figure 1. Prior to the experiment, participants were informed of a colored shape that was the target sign (e.g., green circle). A button press was to be made (with left forefinger) to all target signs, but not to non-target signs, which can differ in either color or shape. A hit on a target sign, indicated by the fixation cross turning green, occurred if the response was made within a pre-defined time window. This time window was established prior to the experiment using a staircase thresholding procedure that individually determined the window duration that resulted in discrimination task performance of 80% accuracy. For details on the thresholding procedures, please see Example 5 below. 33.3 % of the signs were targets, 33.3% were contingent, non-target signs (share the color dimension) and 33.3% were non-contingent, non-target signs (share no feature). Recorded behavioral data included: hits, misses, correct rejections, false positives and response times. Participants received accuracy feedback at the end of each run.

[00141] 2) Single task: Visuomotor tracking (“drive”). Participants viewed a three-dimensional environment with a road extending into the distance. They saw their “car” positioned on a road, 2.5 degrees below a central fixation cross. An example of a screen shot is shown in the middle of Panel B in Figure 1. When the session began, the car would appear to move forward as the road advanced towards the participant. As the road advanced, it curved to the left and right, and participants were instructed to maintain the car in the center of the road (gray zone) using the horizontal axis of the joystick with their right hand, all the while maintaining visual fixation on the cross hair. In addition to the road turning, it was also graded. Participants maintained constant speed by keeping the car within an indicator (speedometer) that advanced on the road along with the car. This was accomplished by using the vertical axis of the joystick to correct for speed changes resulting from hills and valleys; i.e., pushing forward when going up a hill to speed up and pulling back when going down a hill to slow down. The speed of the car was pre-established for each participant prior to each session using a staircase thresholding procedure to attain a performance level of 80% time on road. The exact position on the road relative to center was recorded. Feedback to participants for deviations from the road was

indicated by shaking of the crosshair when off road, and overall time on road was presented at the end of each block.

[00142] 3) Distraction task: Target discrimination while passively exposed to tracking task (“shoot with road”). In this task, participants performed the target discrimination task exactly as described above, but the road was presented as the background, as opposed to the black field used in the single tasks. An example of a screen shot is shown on the right of Panel B in Figure 1. Also, the car advanced along the road on “auto-pilot”. There was no goal to attend to the road or car; it was presented solely as a potential distractor to target discrimination.

[00143] 4) Distraction task: Visuomotor tracking while passively exposed to target discrimination task (“drive with signs”). This task was the mirror version of the other distraction task. Here the goal is to perform visuomotor tracking (“car driving”), while irrelevant visual signs were presented as potential distractors. An example of a screen shot would be similar to the screen shot in distraction task described immediately above.

[00144] 5) Interruption task / Multitasking: Simultaneous target discrimination and visuomotor tracking (“shoot & drive”). The participant performed both single-tasks at the same time. An example of a screen shot would be similar to the screen shot in distraction task described immediately above. Note that there was both perceptual and motor overlap between the two tasks.

EXAMPLE 2 TRAINING

[00145] There were two types of interference training (distraction training and multitasking training), one active control group (single-task training) and a no-contact control group (NCC), which except for the NCC engaged in 12 one-hour training sessions over a 4-week period at their homes. Single-task training involved a randomized alternation between the two single tasks described in the interference assessment section: target discrimination tasks and visuomotor tracking tasks were presented in 3-minute blocks. Comparably, distraction training involved a randomized alternation of the two distraction tasks. Multitasking training will involve 12 sessions of simultaneous target discrimination and visuomotor tracking. Task difficulty at the start of the first session was individually customized based on single-task levels obtained via the thresholding procedure during the preceding lab visit (i.e., road speed and target discrimination response window optimized to result in 80% performance levels on single tasks alone). A major distinction between the training sessions and the neural assessment tasks was that training was adaptive, such that as performance improved, task difficulty increased to maintain constant accuracy (i.e., discrimination time window decreases and road speed increases). Each session was linked such the next session starts at the level attained at the end of the previous session. There were three types of feedback: 1) Real-time feedback - color changes in the fixation crosshair (discrimination task) and shaking of the crosshair (tracking task). 2) Punctuated feedback – the ‘level’ that corresponds to discrimination window time and road speed,

attained at the end of each run is reported. For multitasking training, there was also feedback on the combined performance of each task, presented as the “overall level”. This reflected the lower performing task and so, it encouraged attention to both tasks. 3) At the end of a session, the final session level was reported, as well as a map to visualize where they had “traveled” along this 12-part mountain course. This was included to increase compliance in the entire 12 session training regimen.

[00146] All participants trained at home using laptops and joysticks. At the start of the training period, a person familiar with the experiments presented herein visited participants at home to help set up the computer and to instruct on training. There was also an instruction movie that reinforced the instructions and goals at the launch of each session. Telephone and email support were provided to participants throughout their involvement and they received weekly email reminders and two check-in phone calls. Participants were allowed to set their own training schedule, but were instructed to complete three sessions each week in a distraction-free environment, e.g. without alcohol consumption prior to or during training. During each session, a full set of performance data was recorded on the laptops, so that compliance with protocol was monitored and learning curves were plotted over the training period. In addition, the laptop video camera immediately above the center of the screen was activated at the start each session (indicated by a green light), allowing a visual assessment of the task engagement, as well as motivating participants to be compliant with instructions. Both performance and video data were automatically ported to a secure lab server using a pre-established Dropbox account for those participants with internet connections.

EXAMPLE 3 BEHAVIORAL ASSESSMENT WITH INTERFERENCE

[00147] A behavioral assessment of interference effects in younger (20s) and older adults (e.g. 60-80 years of age) revealed significant distraction and interruption costs both within and between age groups versus the no interference condition. This was seen in the primary task of target discrimination (Figure 3). The same finding was observed for visuomotor tracking for interruption, but not distraction.

[00148] An adult lifespan study of individuals (20-80 years of age) revealed a significant distraction and multitasking cost on the accuracy of target discrimination (Figure 4; left), and a significant multitasking cost on the accuracy of visuomotor tracking for each of the six decades of life studied (Figure 4; right) No impact of distraction on tracking was observed at any age. These interference costs increased with each decade of life and a significant increase in all interference costs were observed between groups of younger and older adults, as classified in the proposed study ($p < .001$). This preliminary study and the significant findings are critical, as it motivates the use of a training regimen to remediate these interference costs.

EXAMPLE 4 EFFECTS OF TRAINING

[00149] 5 younger and 5 older adults participated in 12 one-hour sessions of multitasking training on laptops at home. This pilot study fine-tuned the methods of the present disclosure. Examination of the data from the training sessions revealed consistent improvement across sessions for tracking in every younger and older participant (Figure 5; group data). Of note, there was a distinctly reduced learning slope for older participants. Discrimination performance also improved across sessions in all but two of the participants. The learning curve was more variable across sessions for this performance measure. A completed auditory distraction training also revealed the same pattern of learning shown here in younger and older adults.

[00150] Pre- and post- training evaluation performed in the laboratory revealed that for target discrimination, both distraction (Figure 6; left) and multitasking (Figure 6; middle) costs were reduced in all younger (black) and older (gray) adults, except one. For tracking, every individual resolved multitasking costs (Figure 6; right). Dashed line and asterisks designate the level at which there was no interference cost.

EXAMPLE 5 THRESHOLDING

[00151] The objective of the thresholding algorithm was to achieve as close to about 80% performance in the visuomotor tracking task and/or target discrimination (or target detection) task from the individual by adjusting the difficulty levels appropriately. In a visuomotor tracking task that involved navigating a vehicle on a road (road trial): Increments in difficulty entailed: 1.) a higher perceived road speed, 2.) more momentum by the car (requiring larger corrections) and 3.) faster transitions between road pieces requiring quicker responses (resulting from the higher speed). In a target discrimination task (sign task), increments in sign difficulty entailed a smaller reaction time window to respond to a target stimulus. The algorithm involved in determining a difficulty level employed a combination of staircase thresholding and linear extrapolation over a series of 12 one-minute road trials and 9 two-minute sign trials. Depending on the individual's performance on the previous trial, the difficulty was linearly incremented (if above 80%) or decremented (if below 80%) or held constant (if they performed at 80%). After the completion of all thresholding steps, a difficulty level was calculated by an averaged linear extrapolation for 80% performance ignoring the first three trials (for purposes of giving the individual some familiarity). This procedure was done for the road task and sign task separately yielding two individual scores for that participating individual. As noted above, other percentages of accuracy other than 80% can also be used.

[00152] The training program, which involved the practice of a combined road and sign task took place at the individual's own home for multiple sessions. How difficulty levels were changed was based on the staircase algorithm described above to adaptively change the road and sign

difficulty. Following each three-minute trials, the road and sign difficulty level was linearly adjusted based on the sign and road performance of the previous run. Both difficulty levels were increased only when the participant performed over 80% on signs and road. They were both decreased only when the participant performed below 80% on both objectives. In all other cases, no adjustments were made and the difficulty levels stayed the same for the next run. The difficulty levels the participant ended on were used for the first trial of the next session.

[00153] Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of the appended claims.

CLAIMS**WHAT IS CLAIMED IS:**

1. A method of training to enhance cognition in an individual comprising:
 - presenting a task to said individual,
 - presenting an interference to said individual, wherein said interference is either a distractor or an interruptor;
 - receiving a first input from said individual that has been instructed to respond to said task;
 - if said interference is an interruptor, receiving a second input from said individual that has been instructed to respond to said interruptor; and
 - repeating said previous presenting and said receiving steps continuously in a first trial; and initiating a second trial of said presenting and receiving steps;
 - i) wherein if the number of correct inputs in said first trial reaches a threshold, said second trial has a higher difficulty level than said first trial, and
 - ii) wherein if the number of correct inputs in said first trial is below the threshold, said second trial has lower difficulty level than said first trial; ;and
 - generating an output comprising:
 - i) an analysis of the performance of said individual in the presence of interference;
 and
 - ii) an analysis of the performance of said individual in the absence of interference,
 wherein said method enhances cognition in said individual.
2. The method of claim 1, wherein said interference comprises only distractor and does not comprise an interruptor as interference in any trial.
3. The method of claim 1, wherein said interference comprises only interruptor and does not comprise a distractor as interference in any trial.
4. The method of claim 1, wherein said analysis of the performance in the presence of interference comprises:
 - an analysis of the performance in the presence of a distractor; and
 - an analysis of the performance in the presence of an interruptor.
5. The method of claim 1, comprising an assessment prior to said first presenting step, wherein said assessment comprises presenting a task to said individual in the absence of interference.

6. The method of claim 1, wherein said first trial is at a difficulty level, which corresponds to about 80% correct responses to said task in the absence of interference.
7. The method of claim 1, wherein said interference is an interruptor.
8. The method of claim 1, wherein said presenting a task and said presenting an interference occurs concurrently.
9. The method of claim 1, wherein said presenting an interference occurs in the same frequency throughout a trial.
10. The method of claim 1, comprising generating a feedback as an output that indicates real-time performance of said individual during a trial.
11. The method of claim 1, wherein the task and the interruptor are visual-motor tasks.
12. The method of claim 1, wherein the task is a visual-motor task and the interruptor is an auditory task.
13. The method of claim 1, wherein the task and the interruptor are auditory tasks.
14. The method of claim 1, wherein the task is a target discrimination task or a tracking task.
15. The method of claim 1, wherein said interruptor is a target discrimination task or a tracking task.
16. The method of claim 14, wherein said tracking task comprises presenting a moving vehicle on a winding path and said input of said individual comprises navigating the vehicle on the path.
17. The method of claim 16, wherein a difficulty level of the moving vehicle is based on speed of the vehicle.
18. The method of claim 14, wherein said target discrimination task comprises presenting a plurality of visual stimuli sequentially and said input of said individual comprises pressing a button when a target stimuli appears on a screen.
19. The method of claim 18, wherein said target stimuli is of a specific colored shape.

20. A computer accessible memory medium comprising program instructions for enhancing cognition in a individual, wherein said execution of said instructions causes a device to perform the method of claim 1.

21. A method of training for enhancing cognition in an individual comprising:

executing instructions using a computer system to presenting a task to said individual,
presenting an interference to said individual, wherein said interference is either a distractor or an interruptor;

receiving a first input from said individual that has been instructed to respond to said task;
if said interference is an interruptor, receiving a second input from said individual that has been instructed to respond to said interruptor; and

repeating said previous presenting and said receiving steps continuously in a first trial; and
initiating a second trial of said presenting and receiving steps;

i) wherein if the number of correct inputs in said first trial reaches a threshold, said second trial has a higher difficulty level than said first trial, and

ii) wherein if the number of correct inputs in said first trial is below the threshold, said second trial has lower difficulty level than said first trial; ;and

generating an output comprising:

i) an analysis of the performance of said individual in the presence of interference;

and

ii) an analysis of the performance of said individual in the absence of interference,
wherein said method enhances cognition in said individual.

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Unscannable items
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Documents reçu avec cette demande ne pouvant être balayés
(Commander les documents originaux dans la section de préparation des dossiers au
10^{ème} étage)

Figure 6

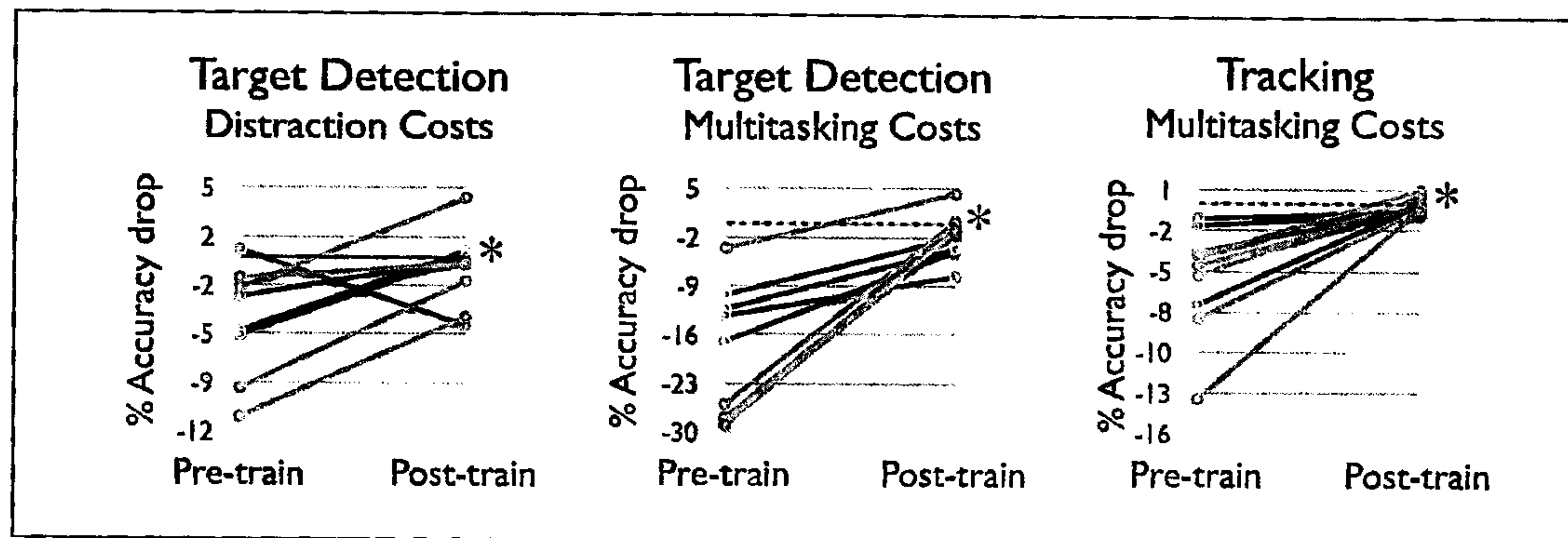


Figure 7

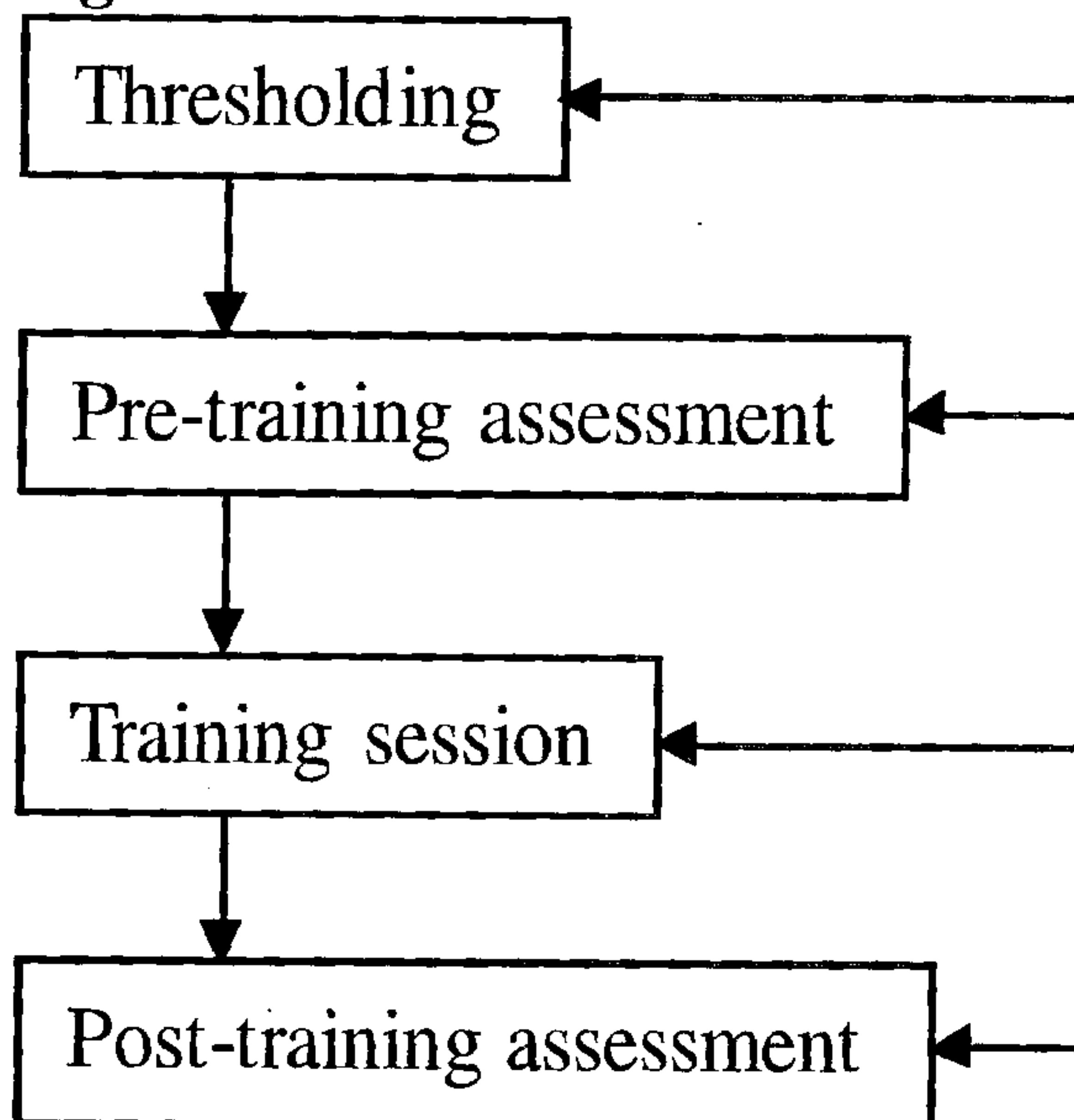


Figure 8