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Development and Testing of The Gait Assessment and Intervention Tool (G.A.I.T.): A Measure of Coordinated Gait Components

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Development and testing of the Gait Assessment and Intervention Tool (G.A.I.T.): A measure of coordinated gait components

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1. Introduction

In recent years, neuroscience studies have provided the basis upon which to construct gait recovery interventions for those who have persistent gait dyscoordination *after stroke* (Daly and Ruff, 2007a). The research evidence of activity-dependent central nervous system (CNS) plasticity (Nudo, 2006; Ziemann et al., 2004; Chu and Jones, 2000; Jones et al., 1999; Biernaskie and Corbett, 2001; Liepert et al., 2001) and the associated principles of motor learning (Plautz et al., 2000; Butefisch et al., 1995; Dean and Shepherd, 1997; Elbert et al., 1995; Pascual-Leone and Torres, 1993; Singer et al., 1993) provide an evidence basis upon which to develop potentially efficacious gait training protocols. Recent work, *with patients after stroke*, has shown that a gait training protocol, which utilized this CNS plasticity evidence basis and motor learning principles, was able to produce significant gains in gait coordination (Daly and Ruff, 2007a; Daly et al., 2007b). With the recent success of the recovery of the coordinated components of gait, it is important to develop credible and useful measures with which to evaluate the response to new, more successful gait training protocols.

One important type of gait assessment is the observational gait assessment, which does not require an expensive motion capture system or special walkway with sensors. There are some existing observational measures of coordinated gait components. Although each existing *observational* measure has its advantages, each *observational measure has its* shortcomings for assessing response to intervention according to the coordinated gait components that compose normal walking. Shortcomings of existing *observational* measures include heterogeneity (e.g., a mix of items measuring temporal/distance gait characteristics, compensatory strategies, and coordinated gait components (Tinetti Gait Scale (TGS (Tinetti, 1986)), Wisconsin Gait Scale (WGS (Rodriquez et al., 1996; Turani et al., 2004)); lack of comprehensiveness (TGS, WGS, Modified Gait Assessment Rating Scale (mGARS (VanSwearingen et al., 1996)), Rivermeade Visual Gait Index (RVGA (Lord et al., 1998)); subjective scoring method (RVGA); and inability to document incremental gains in response to gait training (Rancho Observational Gait Analysis (OGA; Rancho Los Amigos, 2001)).

In assessing response to intervention, it is critical to utilize an objectively-based, accurate, comprehensive measure that is capable of discriminating restoration of volitional control of the coordinated movement components of gait. Without this capability, we forfeit the ability to both credit efficacious rehabilitation methods and justify the financial support of providing effective gait training interventions.

Therefore, it was our purpose to conduct a content validity study in order to develop, test, and provide for use, a new observational measure of coordinated gait components that would be comprehensive, scored in an objectively-based manner, reliable, provide for scoring of incremental gains within given items, and also sensitively quantify response to gait training interventions for those who have had a stroke.

2. Methods

2.1. Evaluators

Eight experienced clinicians worked to develop the measure; they had 5–30 years experience in neurorehabilitation and observational gait analysis. One additional clinician worked to develop the measure; he was relatively inexperienced in neurorehabilitation (4 years of experience in acute and sub-acute care of patients with a variety of diagnoses). The evaluators were employed by the LS Cleveland DVA Medical Center (LSCDVAMC) to complete this work.

2.2. Subjects

Existing data from 29 subjects was used to test the Gait Assessment and Intervention Tool (G.A.I.T.) measure. These subjects participated in a randomized, controlled trial (Daly et al., 2006). The study was conducted under the oversight of the LSCDVAMC, Internal Review Board for human subjects' protection, and written informed consent was obtained.

2.3. Development of criteria

Using a modified Delphi method (Dick, 2000), the clinician team developed the criteria for the new measure, as follows:

(1) Less expensive to administer and to interpret than motion capture systems (regarding equipment, space, and staff time for training and utilization).
(2) As comprehensive, as practically possible, regarding the coordinated movement components of gait.
(3) Based upon defined normal coordinated movements of gait.
(4) Containing an objectively-based scoring system.
(5) Containing a scoring system that could measure improvement in given coordinated movements.
(6) Good reliability.
(7) Capability to identify change in coordinated gait components in response to treatment.

A literature search was conducted to identify existing measures of coordinated movements of gait. We utilized Medline and the Cochrane Data base for the literature search. We identified four existing measures for a more detailed inspection, as those measures that most comprehensively ($\geq$9 items) assessed coordinated movement components of gait: Tinetti Gait Scale, the Wisconsin Gait Scale, Rivermeade Visual Gait Analysis and the Rancho Observational Gait Analysis. Existing measures were evaluated regarding the criteria listed above. Since no single existing measure satisfied all the criteria, we began the process to develop a new measure, the Gait Assessment and Intervention Tool.

To develop a measure with content validity, we used a modified Delphi technique (Dick, 2000), an iterative group process (Portney, 2000), which was conducted by rehabilitation specialists with expertise in gait assessment and gait training for those with neurological diagnoses. The process included iterative cycles during which the team completed one or more of the following tasks: (1) generation and refinement of the evaluative items, the scoring system, and the instructions; and (2) piloting of the measure and incorporation of the findings from the pilot studies into the refinement process. During each cycle of item construction and refinement, the team considered each team member's contributions and reached a consensus regarding item inclusion, item content, item scoring, and measurement instructions. Items were added, deleted, or changed, based on presentation of evidence provided by expert clinicians in the form of video documented examples of gait, published text information, and published journal articles (e.g., Neumann, 2002; Inman et al., 1994; Sutherland et al., 1994; Adams and Perry, 1994; Winter, 1991; Moore et al., 1993; Mosely et al., 1993), all in accordance with content validity study procedures (Portney, 2000). Reliability testing was conducted after there was a consensus that the measure was complete.

First, to test intra-rater reliability, ten subjects (>12 months post-stroke) were evaluated according to the G.A.I.T., by one rater, across two testing periods. Second, inter-rater reliability was tested by two raters who rated a ten subject sub-sample. Third, an inexperienced clinician was trained for three, 1.5-h sessions in using the G.A.I.T. The inexperienced clinician and an experienced clinician then both rated a sub-sample of 15 subjects (>12 months post-stroke), in order to determine the inter-rater reliability that could be obtained for an inexperienced clinician. Reliabilities were calculated using the Intraclass Correlation Coefficient (ICC).

According to our literature search, there was not an existing observational gait measure that was considered a 'gold standard' for measuring change in gait. And all the existing measures were not adequate for the present-day purpose of comprehensively measuring gains in coordinated gait components in stroke patients after innovative gait training methods. Therefore, we did not conduct a conventional criterion-related validity study using an existing observational gait measure. However, in order to provide some information on selected items, we investigated the level of association of two of the G.A.I.T. items with the relevant, respective movement excursion data obtained from a motion capture system, since motion capture kinematic data can be considered a 'gold standard' for research (though motion capture system data are not expected to be equivalent to or used for the same purposes as observational gait measures). Gait kinematic data were acquired using the Vicon 370 motion capture system (Oxford Metrics, UK), a three-dimensional video data acquisition system with seven charge-coupled device cameras arranged on a 30-foot walkway. Reflective markers (15 markers) were placed at anatomical landmarks on the limbs and pelvis using a modified Hayes configuration (Kadaba et al., 1990). Kinematic data for the knee joint movement excursion during the gait cycle was obtained for approximately 30 strides for each subject. Knee flexion at toe-off and peak swing knee flexion were calculated using custom software created in Matlab. Using the 29-subject sample, we calculated the Spearman Correlation between the G.A.I.T. item 26 score (knee flexion at toe-off) and the motion capture data for knee flexion at toe-off. We repeated the procedure for the G.A.I.T. item 27 score (peak swing knee flexion) and the motion capture data for peak swing knee flexion.

The G.A.I.T. was assessed for its ability to identify improvement of gait in response to treatment. A total of 29 subjects (>12 months after stroke) were evaluated according to the G.A.I.T. before and after gait training. A video document data set was used from a previously reported randomized, controlled gait training trial (Daly et al., 2006). Anterior/posterior and lateral-view video documents were used, and a video stop-frame feature was used for a few selected items. The subjects had been randomly assigned to one of two gait training interventions: (1) coordination training, body weight supported treadmill training, and over ground gait training; or (2) identical treatment as listed in number 1, with the addition of an eight-channel functional electrical stimulation (FES) using intramuscular (IM) electrodes (FES-IM; Daly et al., 2001). The G.A.I.T. examiner was blinded as to the intervention received by the subjects. The Mann–Whitney *U*-test for ordinal measures was used to compare the two treatment groups at baseline, according to the G.A.I.T. The Wilcoxon Signed Ranks test for ordinal measures was used for within groups, pre-/post-treatment comparisons, according to the G.A.I.T. The PLUM Ordinal Regression model was used to conduct a comparison of the treatment response to the two interventions, according to the G.A.I.T. measure. In the regression model, the post-treatment G.A.I.T. score was the dependent variable, the pre-treatment G.A.I.T. score was a covariate, and group assignment (no-FES or FES-IM) was the independent variable.

3. Results

The resulting measure, the G.A.I.T. (Appendix A includes the measure and Appendix B includes scoring instructions; online supplementary material) is a 31-item measure, with a perfect score = zero, and a maximum score of gait deficits = 64. Time allocation for both training on the measure and the scoring of the measure was practical. Training was necessary for an inexperienced clinician (three, 1.5-h sessions), and experienced clinicians with academic background in gait assessment needed only 2 h to read and understand the instructions and learn to use the measure itself. The G.A.I.T. can be scored in 20 min.

The G.A.I.T. is divided into 3 sections, and all items pertain to coordinated movement components of gait. Section A contains 4 items of coordinated gait components of the upper extremity and trunk that occur during both stance and swing phase (7 points, maximum). Section B contains 14 items for the trunk and lower extremity that are unique to stance phase (32 points, maximum). Section C contains 13 items for the trunk and lower extremity that are unique to swing phase (24 points, maximum). The measure is homogeneous in that all items are based on defined normal coordinated movements that compose the gait pattern. Deviations from normal are listed as scoring choices within each item. Scoring for each item ranges from 0 (normal) up to 3, with gradients of variation from normal defined and scored as 1, 2, or 3 points. Appendix B provides instructions for the use of lateral and anterior/posterior view video documents.

Table 1A provides comparative information for selected existing measures and the G.A.I.T. in terms of: overall comprehensiveness and technology recommended. The OGA was a checklist of 36 gait deficits, some of which were subdivided into sub-phases of stance and/or swing phases of gait. The G.A.I.T. had 31 items of normal coordinated gait components, some of which contained more than one gait deficit. The remaining measures were at least 40% shorter than the OGA. The OGA and the G.A.I.T. were the only measures for which video documentation was recommended, and the G.A.I.T. was the only measure for which stop-frame/playback capability was recommended for some items.

Table 1B provides information for selected existing measures and the G.A.I.T. in terms of the following: item content homogeneity with respect to coordinated movement components of gait; number of item score choices available; objectively-based scoring

Table 1A
Overall structure and equipment recommended.

Measure	Overall comprehensiveness	Technology recommended
Tinetti Gait (TG)	9 items of gait deficits.	None.
Wisconsin Gait Scale	14 items of gait deficits.	None.
Ranchos Observational Gait Assessment (OGA)	36 items of gait deficits, 8 sub-phases.	Video documents.
Rivermeade Visual Gait Analysis (RVGA)	20 items of gait deficits.	None.
Gait Assessment and Intervention Tool (G.A.I.T.)	31 items of coordinated gait components, containing 45 separate gait deficits occurring as scoring choices within each item.	Video documents. Playback/stop frame for selected items.

Table 1B
Item content and scoring for selected measures of the coordinated movements of the gait pattern.

Measure	Item content homogeneity for coordinated movements of gait components (number of items)	Number of item score choices	Objectively-based item-scoring	Overall scoring method	Ability to discriminate incremental improvement per item
Tinetti Gait Scale	Mixed: timing (2 items); distance (3); combined components (2); non-gait (1); gait deficits (1).	2	Yes (present/absent*)	Yes	No
Wisconsin Gait Scale	Mixed: timing (2); distance (2); aid (1); results of 3-joint actions without scoring the 3 joints (1); inaccurate description, "vaulting" (1); gait deficits (7).	3	Yes	Yes	Yes
Observational Gait Analysis	Homogenous: gait deficits, all items.	2	Yes (present/absent*)	Not given	No
Rivermeade Visual Gait Analysis	Homogeneous: gait deficits, all items.	4	No (mild/moderate/severe)	Yes	Yes
Gait Assessement and Intervention Tool	Homogeneous: coordinated movements of gait, all items.	4	Yes (23 items: amount of deficit defined; 8 items present/absent*)	Yes	Yes

* Gait deficits identified as present or absent.

Table 2
Comparison of item content across three gait measures.

General positioning	OGA	RVGA	G.A.I.T.
1. Shoulder position	No	Yes	Yes
2. Elbow flexion	No	Yes	Yes
3. Arm swing	No	No	Yes
4. Trunk alignment	No	No	Yes
Stance phase			
5. Trunk movement (sagittal plane)	Yes, 3 sub-phases	No differentiation from static position	Yes
6. Trunk movement (coronal plane)	Yes, 3 sub-phases	No differentiation from static position	Yes
7. Weight shift (coronal plane)	No	Yes	Yes
8. Pelvic position (coronal plane)	Yes, 4 phases	Yes	Yes
9. Pelvic tilt (sagittal plane)	Yes	No	Yes
10. Pelvic rotation (transverse plane)	Yes	No	Yes
11. Hip extension	Yes	Yes	Yes
12. Hip rotation	Yes, 3 sub-phases	No	Yes
13. Knee position: initial contact phase	Yes	Yes	Yes
14. Knee position: loading response sub-phase	Yes	Does not discriminate these 3 phases	Yes
15. Knee movement–mid-stance sub-phase	Yes	Does not discriminate these 3 phases	Yes
16. Knee position: terminal stance phase	Yes	Does not discriminate these 3 phases	Yes
17. Ankle movement (sagittal plane)	Yes, 8 sub-phases	Yes	Yes
18. Ankle movement (coronal plane)	Yes	Yes	Yes
19. Plantar flexion: terminal stance phase	Yes, 2 sub-phases	Yes	Yes
Swing phase			
20. Trunk movement (sagittal plane)	Yes, 4 sub-phases	No differentiation from static position	Yes
21. Trunk movement (coronal plane)	Yes, 4 sub-phases	No differentiation from static position	Yes
22. Pelvic position (coronal plane)	Yes, 4 sub-phases	Yes	Yes
23. Pelvic rotation (transverse plane)	Yes	Yes	Yes
24. Hip movement: throughout swing phase	Yes	Yes	Yes
25. Knee position: initial swing phase	Yes	Does not discriminate these sub-phases	Yes
26. Knee position: mid-swing phase	Yes	Does not discriminate these sub-phases	Yes
27. Knee position: terminal swing phase	Yes	No	Yes
28. Ankle movement: swing phase (sagittal plane)	Yes	Yes	Yes
29. Ankle inversion (coronal plane)	Yes	No	Yes
30. Walking aides (AFO, assistive device, physical assist)	No	Present/absent no scoring	Yes

method provided; and potential to measure an incremental change or response to treatment, within given items or gait components. The OGA, RVGA, and the G.A.I.T. were homogeneous; that is, they contained a set of items for the purpose of identifying deficits in coordinated gait components. The TGS and the WGS were mixed, in that they contained items describing temporal and distance gait characteristics, as well as deficits in coordinated gait components and other types of items. The RVGA and the G.A.I.T. had up to four possible score choices, whereas the other measures had up to 2 or 3 score choices per item. All measures except the RVGA had an objectively based scoring system. The TGS and the OGA were not capable of discriminating incremental improvement within any of the individual items; that is, the gait deficit was identified as either present or absent. The WGS (14 items), RVGA (20 items), and the G.A.I.T. (23 items) were capable of identifying gradations of improvement within specific individual items.

Table 2 presents some detail regarding comparisons among the OGA, RVGA, and the G.A.I.T., according to item comprehensiveness. For this table, we selected the G.A.I.T. and the two existing most comprehensive measures, the RVGA and OGA. The OGA was the most comprehensive in that it listed 36 types of gait deficits across sub-phases of swing and stance phase. It was the most comprehensive itemization of gait deficits because it subdivided gait into 8 sub-phases. However, in comparing the OGA to the G.A.I.T., note can be taken that a number of the individual gait deficit items of the OGA were included as scoring choices within a given single item in the G.A.I.T. This occurred because of the difference in the basic structure of the two measures. That is, the OGA was an itemization of all possible gait deviations; however, the G.A.I.T. measure was based upon an itemization of normal coordinated gait movements, so that more than one possible deviation from normal was contained within a given item as a scoring choice in the G.A.I.T. For example, the OGA listed the deficits in stance phase knee control as two separate items, knee hyper-flexion and knee hyper-extension. However, the G.A.I.T. lists stance phase knee control as either normal (0), knee hyper-flexion (1), or hyper-extension (1). Therefore, though the number of items in the G.A.I.T. is fewer than in the OGA, all the OGA gait deficits (except two: knee valgus or varus; and abnormal trunk rotation in the axial plane) are included in the G.A.I.T. The G.A.I.T. and the RVGA are more comprehensive versus the OGA in that the OGA does not assess shoulder position or elbow flexion. The G.A.I.T. is more comprehensive than either the OGA or the RVGA in that it accounts in the scoring of relevant items for the use or freedom from an assistive device, orthosis or manual assistance, and it assesses arm swing and static trunk alignment. Additionally, contained within the G.A.I.T. measure, there is an assessment of all the gait deficits that were addressed in the RVGA. All the items of the G.A.I.T. are unique from all the other existing measures in that they are stated in terms of the normal coordinated gait components. Not only does the G.A.I.T. assess all the gait deficits that are assessed in the RVGA, but also the G.A.I.T. is more comprehensive than the RVGA. For example, the G.A.I.T. provides for assessment of gait deficits for some specific critical coordinated movements during sub-phases of stance and swing.

Intra-rater reliability of the G.A.I.T. was good (Portney, 2000; ICC = .98; $p = .0001$; 95% CI = .95, .99). Inter-rater reliability of the G.A.I.T. was also good (ICC = .83; $p = .007$; 95% CI = .32, .96). Inter-rater reliability between an experienced clinician and a trained, inexperienced clinician was good (ICC = .996; $p = .0001$, CI = .986, .999).

The Spearman Correlation between the G.A.I.T. item 26 score (knee flexion at toe-off) and the motion capture data for knee flexion at toe-off was $r = .65$ ($p = .001$). The Spearman Correlation between the G.A.I.T. item 27 score (peak swing knee flexion) and the motion capture data for peak swing knee flexion was $r = .76$ ($p = .0001$).

The G.A.I.T. discriminated a statistically significant, within-groups, pre-/post-treatment difference for each of two gait training interventions. For comprehensive gait training without FES-IM, $z = -2.93$, $p = .003$. For comprehensive gait training, with FES-IM, $z = -3.3$, $p = .001$.

Additionally, the G.A.I.T. discriminated a statistically significant difference between treatment groups. At baseline, there was no significant difference between the two treatment groups ($z = -1.22$; $p = .24$). The G.A.I.T. showed an advantage for the addition of FES-IM to otherwise comparable and comprehensive gait training (parameter estimate = 1.72, $p = .021$; CI = .254, 3.12).

4. Discussion

This study contributes to the literature, the G.A.I.T., a new content valid, measure of coordinated gait components in that it encompasses, in one measure, the following characteristics: (1) comprehensiveness, (2) homogeneity, (3) objectively-based scoring method, and (4) the capability to measure incremental gains within individual items of the coordinated components of gait. The G.A.I.T. measure was superior to existing observational measures in that each of the prior existing observational measures had one or more of those four characteristics, but no single measure incorporated all of the needed characteristics.

First, the G.A.I.T. is more comprehensive than the TGS, the WGS, and the RVGA. There are more gait components and a greater total score in the G.A.I.T. (31 items; 64 points) versus the TG (9 items; 12 points), or the WGS (14 items; 44 points), or the RVGA (20 items; 59 points). The G.A.I.T. is more comprehensive than the OGA in that it assesses upper extremity function during walking, which has been documented as important (Cappozzo, 1983; Harris and Wertsch, 1994; Webb et al., 1994; Sigg et al., 1997; McGinley et al., 2003; Brunnekreef et al., 2005).

Second, the G.A.I.T. was more homogeneous than the TG. The TG contained not only items assessing gait deficits in the coordinated gait components, but also compensatory strategies and temporal aspects of gait.

Third, compared to the RVGA, the G.A.I.T. was more objectively scored. The G.A.I.T. utilizes the more objective elements of the scoring strengths of several other available measures. For example, 7 of the G.A.I.T. items require a rating of absent/present for gait deficits, similar to the scoring method provided for the OGA. A measure is more likely to obtain accurate scoring based on this type of choice versus the choice of "mild, moderate, severe", which are not defined, and which is the subjective scoring method utilized in the RVGA. Also similar to the OGA, a number of G.A.I.T. items specify sub-phases of stance and swing phase. This can be important in more specifically quantifying an improvement that occurs in only one sub-phase of stance phase or swing phase, but not the entire phase.

Fourth, the G.A.I.T. provided a method of measuring incremental change within some items. That is, 24 of the G.A.I.T. items require a determination of the degree of the deficit. This represents a method of capturing incremental response to treatment within the domain of a given coordinated gait component. In justifying gait training and other interventions that may improve gait, it is critical to utilize measures that assess improvement of a given coordinated gait component, even though the gait deficit may not have completely resolved. If an intervention has a significant positive effect, it is important to quantify that significant effect so that both clinicians and researchers can use the information on behalf of patients. With a measurement tool that measures incremental response to treatment, clinicians can be justified to continue the intervention as long as gains are continuously exhibited. Researchers can be guided to develop potentially promising new gait training methods. In these ways, then, the G.A.I.T. was superior to existing observational measures. That is, the G.A.I.T. was a content valid measure, based on the finding that it was a single measure that possessed all of the following characteristics: (1) comprehensiveness, (2) homogeneity, (3) objectively-based scoring method, and (4) capability to measure incremental gains within individual items of the coordinated components of gait. After establishing content validity, it was important to establish the measure's reliability and capability to discriminate change in response to treatment.

The G.A.I.T. had very good reliability both within and between raters as well as between an experienced and inexperienced clinician who received a short training on the use of the measure. The G.A.I.T. proved to have a respectable association for two of its items with the relevant movement excursion data obtained from a motion capture system. Though it was not our purpose to directly compare the observational G.A.I.T. measure with motion capture data, it was interesting to note that the motion capture data correlated with each of two of the G.A.I.T. items at a level of .65 and .76, for knee flexion at toe-off and peak swing knee flexion, respectively.

After determining that the G.A.I.T. was content valid for the stated purpose and reliable, the next step was to determine whether the G.A.I.T. was capable of identifying change in response to gait training. The G.A.I.T. discriminated a statistically significant gait training response for each of two different treatment groups that received gait training. This discriminatory capability was exhibited in a relatively small sample size ($n = 14$; 15, respectively). Furthermore, the G.A.I.T. discriminated a statistically significant advantage for the group receiving an additional innovative aspect of gait training versus the group receiving an otherwise comparable, comprehensive gait training. This difference was shown with the same relatively small sample size (14; 15, respectively). In exhibiting this type of measurement performance, the G.A.I.T. fulfilled an important purpose: sensitively discriminate response to treatment.

In comparison to other measures, the G.A.I.T. has some disadvantages. First, to date, the G.A.I.T. has been tested for performance characteristics only using video documents and playback/stop-frame capability for some items. It has not yet been studied using in-person ratings. Though some may consider use of video documents a deterrent, researchers reported that therapists using video documentation for gait analysis made accurate judgments (Tinetti, 1986). Second, the G.A.I.T. may require more time because it is more comprehensive (31 items) than some of the other measures that include a scoring method (TG, WGS, RVGA). Though when greater comprehensiveness is desired, it would be important to use the G.A.I.T. Third, though the G.A.I.T. is more comprehensive than other available scored measures, it is not quite as comprehensive as the OGA checklist. That is, the OGA is more comprehensive in that each coordinated gait component can be checked for absence/presence in multiple sub-phases of stance and swing phase. This capability of the OGA renders it an excellent tool for teaching how to identify gait deficits, and the OGA has proven its venerability in this regard for many years, though it is not a scoring tool for change in response to treatment. In contrast, the purpose of the G.A.I.T. is to not only to measure and score deficits in the coordinated movement components composing gait, but also to score their response to intervention.

The justification for developing the G.A.I.T. was, first, that the TGS and WGS were neither homogeneous nor did they offer comprehensive coverage of gait deficits. To our knowledge, the OGA did not offer a quantification scheme. Further, the RVGA, though the most comprehensive existing measure that also offered the option of scoring coordinated movement components of gait, was also incomplete and contained a subjective method of scoring.

In summary, we can note that the G.A.I.T. was reliable and discriminated treatment response well. The G.A.I.T. was capable of discriminating a statistically significant response to treatment for two different gait training interventions. The G.A.I.T. was also capable of discriminating a statistically significant advantage for the group receiving an additional innovative gait training versus the group receiving an otherwise comparable and comprehensive gait training. Both tests of discriminability were accomplished with relatively small sample sizes. With a scoring time of 20 min, the G.A.I.T. can be used in a relatively low-tech environment with a video camera and play-back, stop-frame capability for some items. With its comprehensiveness, reliability, and good measurement of treatment response, the G.A.I.T., may be an important tool for use in justifying the provision of effective clinical rehabilitation, as well the support of promising research for improving the coordinated movements of the gait pattern.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jneumeth.2008.12.016.

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