**Title and Focus of Activity:** Motion Analysis of Sit-to-Stand and Gait Across the Lifespan

*Movement/Task Analysis*

**Contributor(s):** Melissa Peterson PT, PhD, GCS; Brenda Pratt PT DSc [bpratt@fsmail.bradley.edu](mailto:bpratt@fsmail.bradley.edu)

Department of Physical Therapy and Health Sciences, Bradley University, Peoria, IL 61625

**Course Information:** Human Development Across the Lifespan; 3 semester hours; 4th semester (1st spring semester after 2 summer semesters and one fall semester). Students take Neurologic Physical Therapy I (Neuroanatomy, neurophysiology, and neurologic assessment, including gait) concurrently with Human Development. In addition, they have studied normal gait and gait deviations in Functional Anatomy (Summer 1) and mobility and gait assessment in Foundations of Physical Therapy (Fall 1).

**Learning Activity Description:**

Purpose: The purpose of this assignment is to provide the student with an in-depth understanding of common functional movements and how these movements change across the lifespan.

All students will analyze two movements—the sit-to-stand transition and level-surface walking. These

movements will be analyzed for three different individuals—the toddler (18 months), the healthy, young

adult, and the older adult with a history of falls. The movements of these individuals will have

similarities and differences across the lifespan.

A. **Healthy, Young Adult (due early in semester)**

**fPart A of this assignment consists of 2 tasks:**

1. The assignment will begin with the healthy adult. Video of a young adult (graduate student performing tasks in frontal and sagittal planes) with no impairments performing was posted to the course management site. In groups of three, students will analyze these two motions, using motion analysis software and the terminology and phases provided in the posted references. Dartfish or Kinovea may be used for motion analysis. Dartfish must be purchased by the department or students. Kinovea ([www.kinovea.org](http://www.kinovea.org)) is a free motion analysis program (Window compatibility only) that also can be used—see website to download. A Power Point presentation will be developed to present each group’s finished assignment. For purposes of grading, a hard copy of each group’s PowerPoint should be submitted to the instructor. Please also post it to the assigned tool on the course management site.

Use the Dartfish or Kinovea software to identify the start and finish of each phase of the movement. For example, find the start and finish of the loading response in gait or the flexion-momentum phase in sit-to-stand. For each movement phase describe the following:

1. Description of start and finish of movement phase
2. Function of the movement phase
3. Kinematics of the movement phase
4. Kinetics of movement phase (for gait, draw in the ground reaction force using the Dartfish/Kinovea drawing tool)
5. Please demonstrate your ability to measure joint angles by measuring one joint during each phase for both movements. Note whether the “normal” adult in the video demonstrates values within the ranges you found in the literature.

Please consider the whole body, not just the legs. For the gait analysis, describe how features of an individual’s gait interact to minimize the vertical and horizontal excursion of the center of mass of the body and the three rockers – heel, ankle, forefoot.

2. Additionally, think about how changes within the individual and changes to the task and/or environment may change the performance of the movements. Select one intrinsic change (i.e. vision, sensation, weakness) and one task or environmental change (i.e. walking or seating surface, distractions, speed). Initially, we would like you to provide your “best guess” how the movement may change. Then, spend some time searching the literature and provide a very brief summary of how your initial theory compared to what has been reported. Please provide the appropriate American Medical Association (AMA) citation for the articles you use (1-2 articles per change is sufficient). Please submit copies of the articles with your assignment.

Grading for Part A

This portion of the assignment is worth 40 points. You will be graded on the accuracy of your movement description and your description of the influence of intrinsic and extrinsic changes on the movements. Please refer to the attached rubric for a detailed breakdown of points.

B. **Toddler (in middle of semester)**

**Part B of this assignment consists of 3 tasks:**

1. For this assignment, students will analyze an 18 month old. A video of a typically developing toddler performing the sit to stand and gait tasks (video of faculty/staff child performing tasks in frontal and sagittal planes) is posted to the course management site. In groups of three, students will analyze these two motions, using the terminology and phases provided in the posted references. A Power Point presentation will be developed to present each group’s finished assignment. For purposes of grading, a hard copy of each group’s PowerPoint should be submitted to the instructor. Please also post it to the assigned tool on the course management site.

Use the Dartfish or Kinovea software to identify the start and finish of each phase of the movement in a split screen mode to compare each movement phase with the young, healthy adult. For example, find the start and finish of the loading response in gait or the flexion-momentum phase in sit-to-stand. For each movement phase describe the following:

1. Description of start and finish of movement phase
2. Function of the movement phase
3. Kinematics of the movement phase
4. Kinetics of movement phase (for gait, draw in the ground reaction force using the Dartfish/Kinovea drawing tool)
5. Please demonstrate your ability to measure joint angles by measuring one joint during each phase of both movements

6. Differences when compared to the young, healthy adult

\*\*Please consider the whole body not just the legs.

2. Additionally, think about how changes within the individual and changes to the task and/or environment may change the performance of the movements. Select one intrinsic change (i.e. vision, sensation, weakness) and one task or environmental change (i.e. walking or seating surface, distractions, speed). Initially, we would like you to provide your “best guess” how the movement may change. Then, spend some time searching the literature and provide a very brief summary of how your initial theory compared to what has been reported. Please provide the appropriate AMA citation for the articles you use (1-2 articles per change is sufficient). Please submit copies of the articles with your assignment.

3. For gait, each group is to answer the 5 questions below:

1. What are the neurological factors that contribute to the development and refinement of gait?
2. What are the biomechanical factors that contribute to the development and refinement of gait?
3. What are the important determinants that define when a mature gait has been attained?
4. How do these important determinants change during the acquisition of a mature gait?
5. At what age does the typical child achieve a mature gait?

Below the questions, please provide the appropriate AMA citation for the references you use to answer each question. **Please submit copies of the articles with your assignment.**

Grading for Motion Analysis Toddler

This portion of the assignment is worth 55 points. Please refer to the attached rubric for a detailed breakdown of points.

C. **Older Adult with history of Falling (late in semester)**

**Part C of this assignment consists of 3 tasks:**

1. A video of an older adult with a history of falls (video of faculty/staff family member performing tasks in frontal and sagittal planes) performing the sit to stand and gait tasks was posted to the course management site. In groups of three, each group will analyze these two motions, using the terminology and phases provided in the posted references. A Power Point presentation will be developed to present your group’s assignment. For purposes of grading, a hard copy of each group’s PowerPoint should be submitted to the instructor. Please also post it to the assigned tool on the course management site.

Use the Dartfish or Kinovea software to identify the start and finish of each phase of the movement in a split screen mode to compare each movement phase with the young, healthy adult. For example, find the start and finish of the loading response in gait or the flexion-momentum phase in sit-to-stand. For each movement phase describe the following:

a. Description of start and finish of movement phase

b. Function of the movement phase

c. Kinematics of the movement phase

d. Kinetics of movement phase (for gait, draw in the ground reaction force using the Dartfish drawing tool)

e. Please demonstrate your ability to measure joint angles by measuring one joint during each phase of both movements

f. Differences when compared to the young, healthy adult

\*\*Please consider the whole body not just the legs.

2. Additionally, think about how changes within the individual and changes to the task and/or environment may change the performance of the movements. Select one intrinsic change (i.e. vision, sensation, weakness) and one task or environmental change (i.e. walking or seating surface, distractions, speed). Initially, we would like you to provide your “best guess” how the movement may change. Then, spend some time searching the literature and provide a very brief summary of how your initial theory compared to what has been reported. Please provide the appropriate AMA citation for the articles you use (1-2 articles per change is sufficient). Please submit copies of the articles with your assignment.

3. For the third part of this assignment, select one of the impairments identified as contributing to the altered movements in the older adult for each task (one for STS, one for gait). Using the literature as a guide, create a VIDEO to capture a treatment session designed to treat the identified impairment. One student should play the part of the PT and one the part of the patient. Demonstrate two intervention strategies you would use to remediate the impairment identified in the STS and gait movement.

IMPORTANT: Please provide a brief written description/rationale for the interventions you have chosen. Please cite at least one reference (published within the past 5 years) for each task described.

**In this word document, include a Youtube link to your video**. The Youtube video should be posted using the **Unlisted** privacy setting. Please also post the word document to the assigned tool on the course management site.

Grading for Part C

This portion of the assignment is worth 70 points. Please refer to the attached rubric for a detailed breakdown of points.

Time for student to complete the activity: Preparation for activity outside of/before class: 12 hours total

(approximately 4 hours for each of the 3 components of the assignment)

Readings/other preparatory materials:

1. Schenkman M, Berger RA, Riley PO, Mann RW, Hodge WA. Whole-body movements during rising to standing from sitting. *Physical Therapy*. 1990;70: 638-648.
2. Gait: Overview, Overall Measures, and Phases of Gait. <http://courses.washington.edu/anatomy/KinesiologySyllabus/GaitPhasesKineticsKinematics.pdf>. Accessed October 11, 2015.
3. Stout J. Gait: Development and analysis. In: Campbell SK, Palisano RJ, Orlin MN, eds. *Physical Therapy for Children*. 4th ed. St. Louis, MO: Elsevier, 2012. <https://evolve.elsevier.com/cs/product/9781455777150?role=faculty>. Accessed October 10, 2015.
4. Burnfield JM, Norkin CC. Examination of Gait. In: O’Sullivan SB, Schmitz TJ, Fulk GD, eds. *Physical Rehabilitation.* 6th ed. Philadelphia, PA: FA Davis; 2014:251-259.

Learning Objectives:

1. Identify the following related to the sit-to-stand and gait movements: description of start and finish of each movement phase, function of each movement phase, kinematics of the each movement phase, and the kinetics of each movement phase
2. Perform motion analysis using motion analysis software to include start and finish of each movement phase, drawing of joint angles measurements, and drawing of ground reaction forces in gait movement.
3. Compare the motion analyses of the young, healthy adult, toddler, and older adult with fall history to the expected ‘values’ for the healthy adult.
4. Identify the similarities and differences between the motion analyses of the young, healthy adult, toddler, and older adult with fall history.

Methods of evaluation of student learning:

The instructor does a motion analysis of the sit-to-stand and gait of the young, healthy adult, the toddler, and the older adult with a history of falls to provide a model by which to grade the assignment and to provide a model for the assignment for student review after the assignment is graded and returned.

1. Rubric for Young, Healthy Adult Motion Analysis:

Description of motion (20 points total):

Correct identification of the start and finish of each phase (4 pts total)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Accurate description of the Function of each phase- (4 pts total)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinematics of phase (accurate description of movement of body segments, joint angles, etc) – (4pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinetics of phase: Accurate description of ground reaction forces, movement of COM – (4 pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinetics of phase: Muscle Activation Patterns (what muscles are firing?) (4 pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Influence of intrinsic factor (how does the intrinsic factor change the movement?) (6 pts): \_\_\_ pts

Gait (3 pts) – \_\_\_ pts

STS (3 pts) – \_\_\_ pts

Influence of extrinsic factor (how does a change in task/environment alter the movement? (6 pts): \_\_pts

Gait (3 pts) – \_\_\_ pts

STS (3 pts)- \_\_\_ pts

Use of motion analysis software (accurate in drawing joint angles, GRF) (4pts): \_\_\_pts

Presentation mechanics (4 points total): \_\_\_ pts

Writing mechanics (grammar, spelling, punctuation) – \_\_\_ pt

Appearance (neat, organized and easy to read) – \_\_\_ pt

References (empirical sources, relevant) – \_\_\_ pt

AMA citation (formatted correctly) – \_\_\_ pt

/ 40 pts

2. Rubric for Toddler Motion Analysis:

Description of motion compared/contrasted to Healthy Young Adult (20 points total):

Correct identification of the start and finish of each phase, with differences highlighted (4 pts total)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Accurate description of the Function of each phase with differences highlighted (4 pts total)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinematics of phase (accurate description of movement of body segments, joint angles, etc) with differences highlighted – (4pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinetics of phase - Aaccurate description of ground reaction forces, movement of COM with differences highlighted – (4 pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinetics of phase - Muscle Activation Patterns (what muscles are firing?) with differences highlighted (4 pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Influence of intrinsic factor (how does the intrinsic factor change the movement?) (6 pts): \_\_\_ pts

Gait (3 pts) – \_\_\_ pts

STS (3 pts) – \_\_\_ pts

Influence of extrinsic factor (how does a change in task/environment alter the movement? (6 pts): \_\_pts

Gait (3 pts) – \_\_\_ pts

STS (3 pts)- \_\_\_ pts

Questions (accurate and complete) (10 points total) : \_\_\_ pts

Q1 (neurological factors contributing to gait refinement)-

Q2 (biomechanical factors contributing to gait refinement)-

Q3 (determinants of mature gait)-

Q4 (changes during mature gait acquisition)-

Q5 (age of mature gait)-

Use of motion analysis software (accurate in drawing joint angles, GRF) (4pts): \_\_\_pts

Presentation mechanics (4 points total): \_\_\_ pts

Writing mechanics (grammar, spelling, punctuation) – \_\_\_ pt

Appearance (neat, organized and easy to read) – \_\_\_ pt

References (empirical sources, relevant) – \_\_\_ pt

AMA citation (formatted correctly) – \_\_\_ pt

/55 pts

3. Rubric for Part C—Older Adult

Description of motion compared/contrasted to Healthy Young Adult (20 points total):

Correct identification of the start and finish of each phase, with differences highlighted (4 pts total)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Accurate description of the Function of each phase with differences highlighted (4 pts total)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinematics of phase (accurate description of movement of body segments, joint angles, etc) with differences highlighted – (4pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinetics of phase - Accurate description of ground reaction forces, movement of COM with differences highlighted – (4 pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Kinetics of phase - Muscle Activation Patterns (what muscles are firing?) with differences highlighted (4 pts)

Gait (2 pts) – Loading Response, Midstance, Terminal Stance, Pre-swing, Initial Swing, Midswing, Terminal Swing - \_\_\_ pts

STS (2 pts) – Flexion Momentum; Momentum Transfer; Extension; Stabilization – \_\_\_ pts

Influence of intrinsic factor (how does the intrinsic factor change the movement?) (6 pts): \_\_\_ pts

Gait (3 pts) – \_\_\_ pts

STS (3 pts) – \_\_\_ pts

Influence of extrinsic factor (how does a change in task/environment alter the movement? (6 pts): \_\_pts

Gait (3 pts) – \_\_\_ pts

STS (3 pts)- \_\_\_ pts

Use of motion analysis software (accurate in drawing joint angles, GRF) (4pts): \_\_\_pts

Presentation mechanics (4 points total): \_\_\_ pts

Writing mechanics (grammar, spelling, punctuation) – \_\_\_ pt

Appearance (neat, organized and easy to read) – \_\_\_ pt

References (empirical sources, relevant) – \_\_\_ pt

AMA citation (formatted correctly) – \_\_\_ pt

Intervention video (30)

Gait (15 pts)

Choice of impairment for treatment focus and rationale

Use of evidence in decision-making

Accuracy of demonstration (verbal/manual cues, positioning, feedback, exercise prescription, etc)

STS (15 pts)

Choice of impairment for treatment focus and rationale

Use of evidence in decision-making

Accuracy of demonstration (verbal/manual cues, positioning, feedback, exercise prescription, etc)

/70 pts