What is the purpose of IRB?
What are the phases of the gait cycle?
What is the relationship between the GRF and the gait cycle?
What are the determinants of gait?
Three basic principles: *respect for persons, beneficence, and justice.*

**Respect for Persons**

**Beneficence**

**Justice**
Milgram experiment

- 1961 Yale Psychologist
- in response to the Nuremberg Trials
- "Obedience to Authority Study"

![Diagram of Milgram experiment]
Tuskegee syphilis experiment

- Conducted between 1932 and 1972
- 600 African-American sharecroppers
  - (400 with disease, 200 controls)
- Natural progression of untreated syphilis
- Tuskegee Institute, U.S. Public Health Service
+ Stanford prison experiment

- 1971
- 24 male students; randomly assigned roles of prisoners and guards
- Mock prison situated in the basement of the Stanford psychology building
- [http://www.prisonexp.org/](http://www.prisonexp.org/)
- US Office of Naval Research
The Immortal Life of Henrietta Lacks

- Henrietta Lacks poor black tobacco farmer
- 1951
- HeLa cell line—taken without her knowledge
- Vital for developing the polio vaccine, cloning, gene mapping, in vitro fertilization, and more..

http://rebeccaskloot.com/the-immortal-life/
Gait terminology
Phases of the Gait cycle
8 phases of gait with GRF vector (on subject) and muscle activity

Initial Contact | Loading Response | Midstance | Terminal Stance

Pre-swing | Initial Swing | Mid-Swing | Terminal Swing
Ground reaction forces during walking

Subject body weight = 681 N

Contact force plate with right foot
Averages for normal healthy adults:
Ground reaction forces under the foot

Natural cadence

Forces normalized by body mass

Horizontal force = anterior-posterior (fore-aft) directed force

Winter et al.
Cop under foot while walking


http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3082780/
**Figure 4**
Diagram shows center of pressure patterns during a normal stride in X-axis direction during a normal stride among (a) normal and (b) neuropathic subjects with drop foot.

**Figure 5**
Diagram shows center of pressure patterns during a normal stride in Y-axis direction during a normal stride (a) normal and (b) neuropathic subjects with drop foot.

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3082780/
Compass gait $\rightarrow$ Normal gait

Determinants of gait

See McMahon text
Determinants of gait

(1) pelvic rotation
(2) pelvic tilt
(3) knee flexion during stance
(4&5) plantarflexion during heel strike and heel off
(6) lateral displacement of pelvis
(7) ankle inversion-eversion-inversion during stance
(8) lateral flexion of trunk
(9) anterior-posterior flexion of trunk

change in potential energy ~ 70 J

normal gait

energy ~ 35 J
Pelvic rotation (transverse plane)
+ Pelvic rotation (cont)
Pelvic tilt
+ Knee flexion

- - - - With no knee flexion

- - - - With knee flexion
Plantarflexion
Put it together... sagittal plane
Lateral pelvic displacement

- During stance, the pelvis shifts laterally towards the stance phase limb.
- This moves the COG closer to the stance leg, making it easier for the stance-side hip abductors to raise the swing leg and control pelvic tilt.
- This results in horizontal (transverse plane) oscillation of the COG with an amplitude of ~5cm, and frequency one-half that of vertical (sagittal plane) movement (~1 Hz vs. 2 Hz).
Abductor lurch

- Exaggerated lateral shift due to loss of hip abductors (gluteus medius, gluteus minimus) on stance side
- Pelvic tilt is opposite to “Trendelenburg gait"
- Apes have Abductor lurch
Monday

- Motion capture
- Body segments
- Joint rotations
- Inverse kinematics