INTRODUCTION
Stride-to-stride fluctuations at the ankle, measured with the largest Lyapunov exponent (LyE), have been found to be strongly correlated to prosthesis preference (Wurdeman, 2013). This type of evaluation stems from our theoretical approach that the prosthesis and the patient are working together, rather than opposing each other, organizing into a more desired and optimal solution. Furthermore, a less appropriate prosthesis design based on Medicare K-level classification has been shown to have greater stride-to-stride fluctuations (i.e. increased LyE) (Wurdeman, 2014). Thus, an appropriate prosthesis may present a condition that leads to a more predictable behavior as the prosthesis and patient work together. Therefore, the purpose of this study was to determine the relationship between stride-to-stride fluctuations, measured by the LyE, before and after receiving a new prosthesis.

METHOD
Subjects: 21 transtibial amputees consented to participate in this IRB approved randomized, crossover design study (age: 54.2 ± 10.6 yrs; ht: 177.2 ± 8.1 cm; mass: 102.6 ± 19.0 kg; time since amputation: 6.6 ± 5.7 yrs).

Procedures: Subjects were randomly fitted with either an appropriate or less appropriate prosthesis according to their K-level. A certified prosthetist swapped out the subjects’ prescribed foot/ankle/pylon for the test components followed by proper alignment. Next, subjects walked on a treadmill at their self-selected pace for 3 minutes while kinematics were recorded (12 cameras, 60 Hz; Motion Analysis Corp., Santa Rosa, CA). After a 3 week adaptation period (English, 1995), testing was repeated followed by swapping components with the other design (appropriate or less appropriate). Testing was repeated again following initial fitting of the other prosthesis and after 3 weeks of wear.

Data Analysis: Ankle angle time series were analyzed using the LyE (Wurdeman, 2013). Pearson correlations were used to test relationships for initial ankle LyE (prosthetic and sound ankle) and final ankle LyE (prosthetic ankle) (α=0.05).

RESULTS
A strong relationship for LyE of the appropriate prosthesis design was found for the prosthetic ankle at initial fitting and final visit (r=0.783, p<0.001; Fig 1a). A moderate relationship was found for the sound ankle LyE at initial fitting and prosthetic ankle LyE at final visit for the appropriate prosthesis design (r=0.449, p=0.041; Fig 1b).

DISCUSSION
When a patient receives a new prosthesis, learning occurs as the neuromuscular system explores the mechanics of the prosthesis to formulate a walking pattern. If the prosthesis is of an appropriate design for the individual, an expected walking pattern emerges based on the initial fitting conditions. A less appropriate prosthesis does not result in such expected outcomes. These behaviors are possibly predictable from the initial behavior of the sound leg ankle motion as well, albeit a weaker correlation.

CONCLUSION
Stride-to-stride fluctuations are related before and after adaptation to an appropriate prosthesis. This represents the ability for an expected behavior to emerge under proper initial fitting. When the design was less appropriate, this relationship does not exist and the resulting gait is not predictable as the individual and prosthesis have likely failed to organize into a proper solution.

CLINICAL APPLICATIONS
The LyE may be a useful prescriptive and/or outcome assessment tool allowing the proper identification of an appropriate prosthesis design.

REFERENCES

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