INTRODUCTION
Walking on ramps can decrease stability and control as kinematics change to accommodate sloped terrain. Transfemoral amputees (TFA) have difficulty walking on ramps. Knee components are mainly designed for flat ground ambulation leaving ramp performance uncertain. Because TFAs encounter ramps in daily activity, contemporary prosthetic components are including ramp gait functions. The C-Leg microprocessor knee dampens knee flexion and has been shown to improve hill descent quality. The Hill Assessment Index (HAI) is an 11-item instrument that scores gait quality on sloped terrain. The HAI has not been evaluated for reliability. Furthermore, there is sparse evidence confirming the improved gait quality in ramp descent observed by using the C-Leg. Therefore, this study’s purpose was to determine if improved gait quality on ramp descent could be replicated with the C-Leg and to evaluate HAI inter-rater reliability.

METHOD
Twenty-one TFAs consented and USF’s IRB approved the protocol. Inclusion criteria: unilateral TFA, ≥90d NMPK use, community ambulation without assistive aid, ramp descent ability. Subjects were first tested on their NMPK then fit and aligned with a C-Leg and allowed to accommodate. Then they retested on a 4.9m length ramp (5° ADA slope & 0.9m wide) using their C-Leg. Subjects walked down the ramp at self-selected pace using handrails as needed. Each trial was timed and videotaped for HAI scoring independently by 2 separate raters. Raters scored ramp walking performances by reviewing videos and determining HAI scores.

Statistical Analyses: The following comparisons were made using paired sample t-tests:
1. NMPK vs. C-Leg Comparisons:
   a. Rater 1: Sample mean HAI score
   b. Rater 2: Sample mean HAI score
   c. Ramp descent duration (sample mean)
2. Rater 1 vs. Rater 2 Comparisons:
   a. Sample mean HAI score NMPK
   b. Sample mean HAI score C-Leg

Comparisons 1a-c above indicate ramp performance between knees. For these comparisons, Cohen’s d was calculated to determine effect size. Comparisons 2a & b were indicators of HAI’s inter-rater reliability. In addition to comparisons 4 & 5 above, inter-rater reliability for individual HAI scores was further evaluated by calculating intra-class correlation coefficients (ICC) and Pearson correlation coefficient (r). Statistical significance was p≤0.05. Statistical analyses were performed by an investigator blinded to the data collection with SPSS software.

RESULTS
Sample Demographics: Twenty one (n=21) K3/4 level TFAs (11male & 10female) comprised the sample. Mean(SD) age: 52.1y(±18.6) & BMI: 23.6kg/m²(±4.2). Amputation etiology, initial NMPK’s and feet varied. Statistically significant differences(p≤0.05) in mean HAI scores were found for both raters’ NMPK and C-Leg scores as well as the duration to complete the task with C-Leg requiring less time to descend the ramp. Effect sizes were consistently at a medium magnitude (0.42-0.53).

Significant differences were not observed between rater 1 and 2’s HAI scores for the NMPK or C-Leg conditions. Instead, strong correlations were found between raters’ HAI scores for both NMPK (ICC=0.96; p<0.001) and C-Leg (ICC=0.99; p<0.001).

Pearson Correlation Coefficients between raters were strong for both knee conditions.

DISCUSSION
Ramp Descent Performance with HAI: Hafner et al. observed ramp descent over a 28.2m length slope in 19 TFAs and reported higher HAI scores with C-Leg(7.7/11) compared to NMPK(6.3/11). Our results were similar suggesting C-Leg use increases HAI score, or ramp descent ability by ~1.1-1.4 points. Additionally, subjects descended 12% faster using C-Leg compared to NMPKs. Increased gait speed has been demonstrated multiple times with C-Leg use.

Inter-rater Reliability of the HAI: Given the HAI was created ad-hoc, it’s reliability has not been evaluated. Mean differences between rater 1 & 2 for the NMPK was ~4% and there was no difference in mean HAI scores between raters with the C-Leg. Through 2 measures, strong correlations were found in both knee conditions between raters. Thus, multiple raters can use the HAI independently and arrive at comparable scores.

CONCLUSION
This study confirms that C-Leg improves ramp descent performance at ADA grades in terms of HAI scores and time to descend the ramp. Additionally, the HAI demonstrated very good inter-rater reliability.

CLINICAL APPLICATIONS
Prosthetists will benefit from knowing ramp gait can improve and that HAI is a reliable instrument for quantifying the performance.

REFERENCES
Buell NC et al. 11th World Congress ISPO 2004 Hong Kong.