DISCRIMINATING BETWEEN SINCERE AND FEIGNED TRUNK MOTION EFFORTS: USE OF THE VARIANCE RATIO FOR QUANTIFYING KINEMATIC CONSISTENCY

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INTRODUCTION
Evaluation of trunk motion characteristics may assist clinicians in determination of the extent of impairment or disability. However, an underlying assumption related to the validity of test results is that the participant was cooperative during trial performance. Previous research has suggested that during performance of sincere trunk movement efforts, variations between successive trials are small. Conversely, during an attempt to feign the presence of pain or injury; set internal consistency is compromised. These compromises are most apparent when examining higher derivatives of trunk angular position data [1,2]. In this investigation, we explore the use of a single representative measure, namely the Variance Ratio (VR), to differentiate between sincere and feigned effort attempts.

METHODS
A convenience sample of 44 asymptomatic individuals (21 men, 23 women, age range 19-27 years) performed 4 sets of 6 continuous trunk flexion and extension repetitions. For the first 2 sets, participants were instructed to perform movements at a self-selected, comfortable pace through their full individual range of motion. For the last 2 sets, participants were asked to feign back injury or pain for secondary gain purposes, whilst attempting to convince the examiners that they are performing to the best of their ability. Three-dimensional kinematic data of the trunk and pelvis were collected using an electromagnetic tracking system (Polhemus Liberty, Colchester, VT). Trunk-pelvis angular joint positions were calculated and subsequently differentiated for the primary plane of movement into obtain joint angular velocity data. These data were segmented to individual repetitions and time normalized to 100% of the movement phase. (Figure 1). Data from repetitions 2 through 6 in each set of the same type (sincere or feigned) were arranged into a 10 x 101 matrix and the VR was calculated to quantify individual intra-set consistency. To establish the accuracy of the VR in the ability to discern between effort types, cut-off scores (CS) were established by calculations of one-sided tolerance intervals at a level of 99% of sincere efforts with a probability of 99% based on a bivariate normal distribution score assumption. The number of false positives (FP) and negatives (FN) was subsequently determined, and expressed as specificity and sensitivity percentages.

RESULTS
Table 1 presents descriptive statistics of the VR within each condition. Sincere efforts were characterized be a lower VR and relatively narrow score variation across participants. Feigned efforts were, on average, less consistent (higher VR value) with large intra-participant variability. Utilizing a VR cut-off score corresponding to 100% specificity within the sample, 4 feigned efforts were misclassified as being maximal (90.9% sensitivity). Utilizing the more generalizable cut-off score, the VR identified 82% of feigned efforts with 99% confidence, with no case of a sincere effort being misclassified as feigned (100% specificity).


disability.

DISCUSSION & CONCLUSIONS
The sensitivity and specificity values obtained are comparable to those reported previously [1,2]. However, the current protocol utilizes measurement equipment that is less specialized, as well as relies on only a single parameter to differentiate between effort types. Future research will assess the ability of other time-series data analysis techniques to improve upon test sensitivity values, as well as expand to evaluation of symptomatic participants.

REFERENCES

Table 1: Performance of the Variance Ratio in differentiating between sincere and feigned trunk extension/flexion efforts.

<table>
<thead>
<tr>
<th>Condition</th>
<th>VR Sincere</th>
<th>VR Feigned</th>
<th>Tolerance Interval P = 0.99, α = 0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SD</td>
<td>0.04±0.02</td>
<td>0.20±0.12</td>
<td>CS 0.109 FP 0/44 (100%) FN 8/44 Specificity 100% Sensitivity 81.8%</td>
</tr>
</tbody>
</table>

Figure 1: Exemplar trunk flexion/extension angular velocity time series for sincere (VR = 0.036) and feigned efforts attempts (VR = 0.284).