Evaluating Trombone Performance Using an Ultrasonic Ranger to Measure Slide Position

Jason Haaheim

Department of Physics

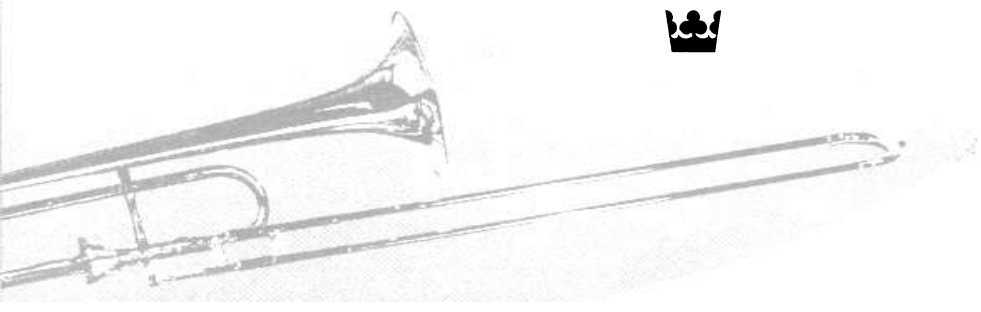
advisors:

Dr. Charles Niederriter, *physics*

Dr. Mark Kruger, *psychology*

Dr. Mark Lammers, *music*

Gustavus Adolphus College
St. Peter, MN, USA



Outline

- Introduction
- Theory
- Experimental Methods
- Results
- Discussion
- Conclusion
- References

Introduction: the Goal

Why are we doing this?

- Establish a biomechanical link between technical ability and movement efficiency
- Develop a better understanding of expertise in skilled movements.
- Challenge or confirm the folk wisdom developed by teachers of trombone performance

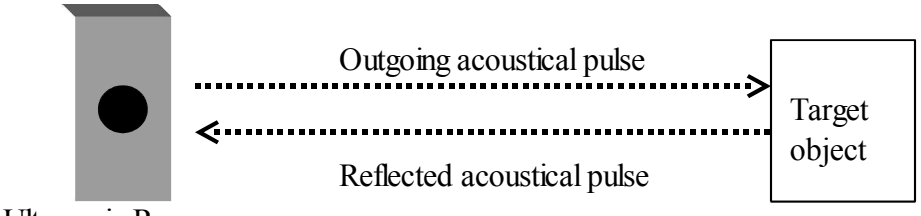
Theory

- The trombone's natural pitch dependence on slide position
- Slide movement achieved in discrete time intervals
- Several factors influence time required to move from one position to another
- This movement necessitates measurement

Measuring Device

- Measurement achieved using Ultrasonic Ranger

- Operates on principle of acoustical reflection



Software times pulses and tells transducer when to emit or receive

Experimental Methods

How are we gathering data?

- Use ultrasonic ranger to measure the distance differential between fixed point and trombone slide during playing

Measurement issues

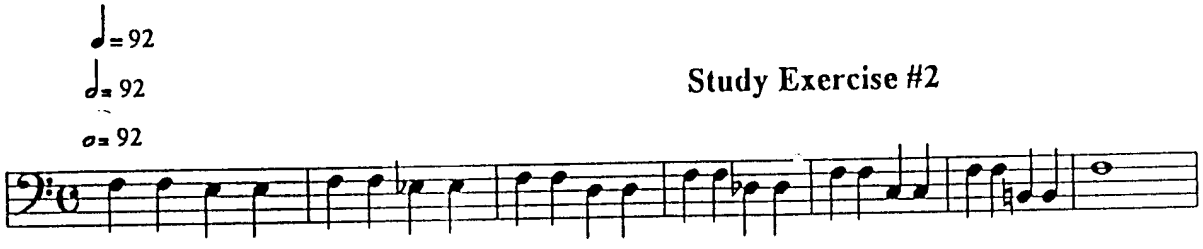
- Motor Control: with experts, one would expect consistent motion—not necessarily true

- Neophytes' motions are even less controlled

Previous Methods

- Original experimental setup

- Performers were asked to play the following music. It measures motion to all seven positions of the trombone slide



Previous Methods

- Difficult to draw conclusions—young players move too much

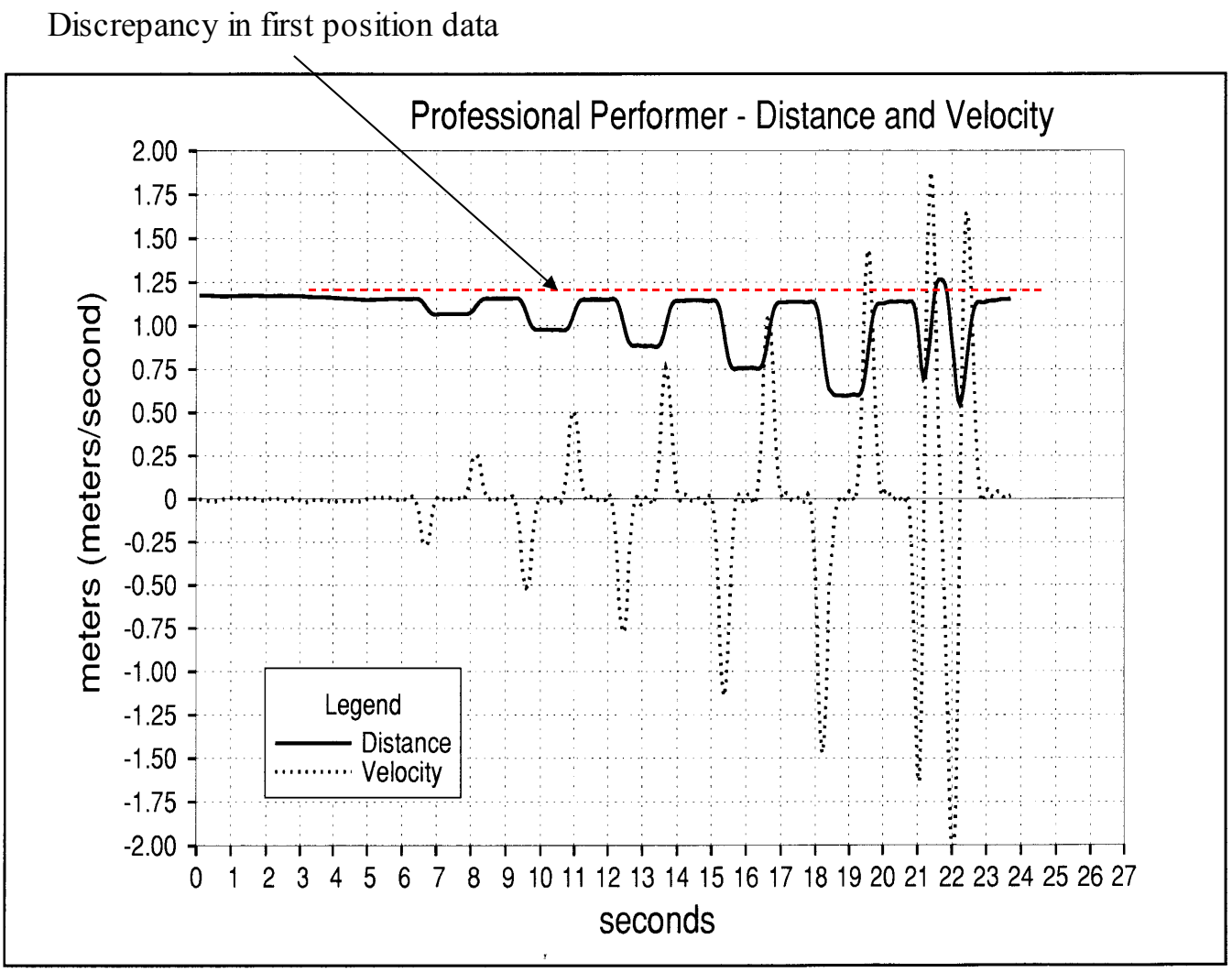
- Variability of beginning performers' movement overwhelmed measurement system—rotating torso, moving trombone slide from side to side

- Should be possible to examine slide motion independent of extraneous motion.

Previous Methods

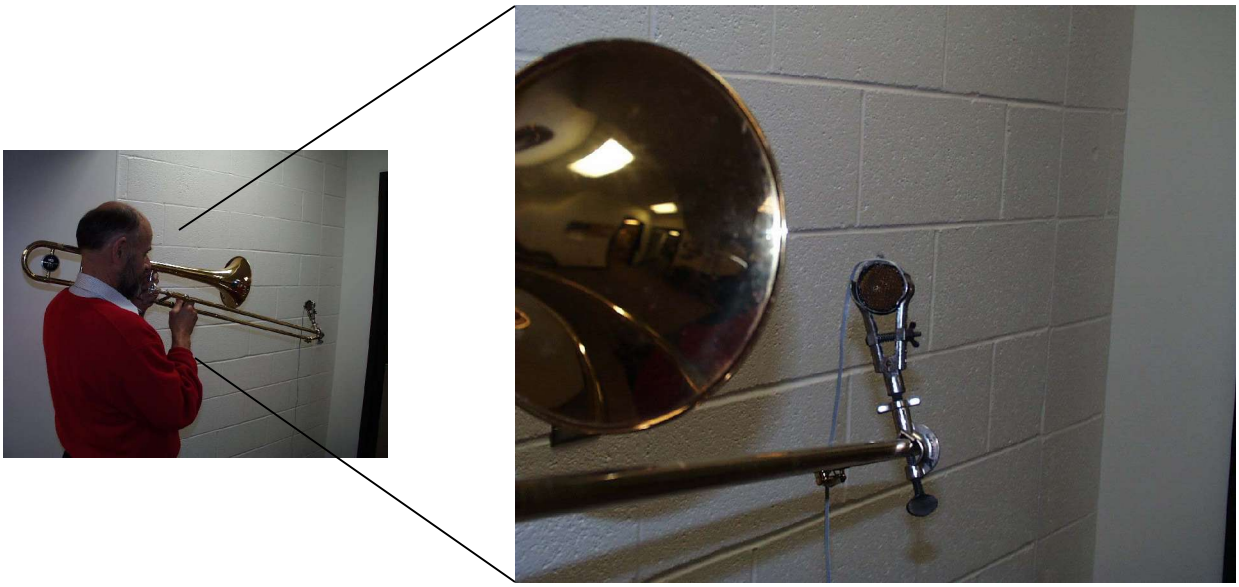
non-normalized data set

- Peak to peak difference in 1st position measurement shown
- Thus need to measure slide motion independent of other extraneous motion



Current Method

- System for measuring slide motion independently shown below



Advantages

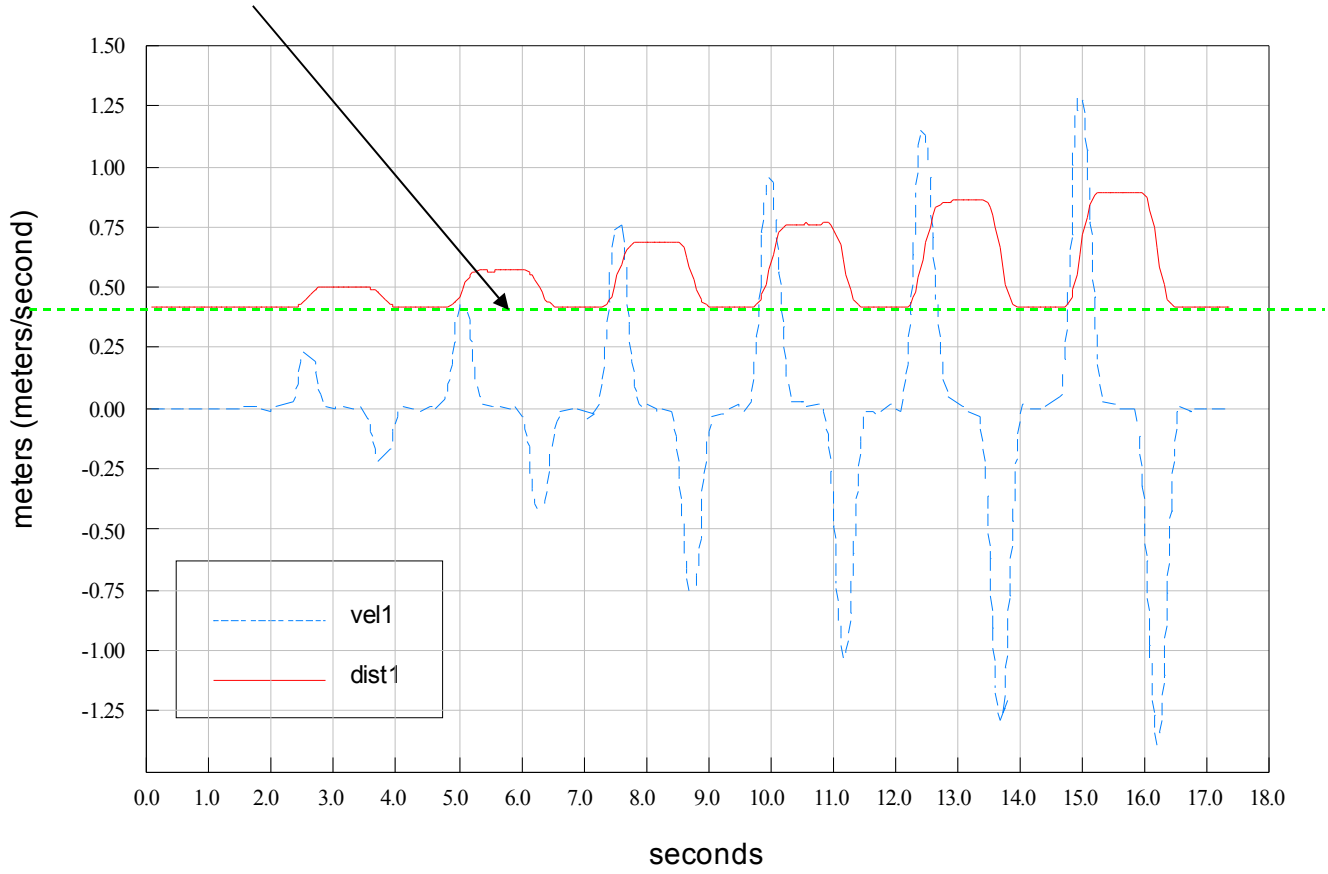
- Very lightweight (newer model not shown)
- Not cumbersome
- Does not detract from playing
- Unaffected by extraneous motion

Current Method

normalized data set

- Current technique maintains consistently normalized motion field
- **NOTE**: All of the peaks are in the same place!
- Peak inversion due to inverted setup.

Complete agreement in first position data



Results

What our group has found

Expected

- The professional trombone players used less muscle activity than student performers to play the musical exercise.
- The professionals used less time to move the slide from position to position. Thus, for a given note, they were in the correct position longer than students.

Unexpected

- Each performer moves the slide as fast as they need to depending on the requirements of the motion.

Discussion

How can this information be used?

- Music Educators
- Performers
- Instrument Manufacturers

Future Steps

- LABView will soon be employed to consolidate data acquisition sources and have unified experiment operating system
- Will make it very easy to add EMG (Electromyographical) simultaneous data acquisition in real time
- Easy to match spectral analysis data to distance/velocity vs. time data and compare—more sophisticated analysis of performance

Conclusions

What worked?

- Solved extraneous motion problem—data acquisition is normalized. Can now easily analyze data.

How can we improve it?

- Transfer old transducer code to LABView. Finalize LABView compatibility and interface.
- Data analysis will be more complete when we can add EMG and Spectral Analysis acquisition and link them in real-time

References

Kruger, M., Lammers, M. Stoner, L. Allyn, D., & Fuller, R. (1996) "Musical Expertise: The dynamic movement of the trombone slide." Found in Haake, S.J. (Ed.) *The Engineering of Sport*. Amsterdamn, Netherlands, A.K. Balkema Publishers.

Kruger, M., Lammers, M. Stoner, L. Allyn, D., & Fuller, R. (1997) "Biomechanics of musical performance: Moving the trombone slide." *Proceedings of the Third Triennial Conference of the European Society of Cognitive Sciences of Music* held at Uppsala University, Uppsala, Sweden.

Lammers, M., Kruger, M. (1991) "The right arm of trombonists: A pedagogical reference." *Journal of the International Trombone Association*, 19(3), 14-17.

Lammers, M., Kruger, M., Fuller, R., Stoner, L., Allyn, D. (1996) "Biomechanics of Musical Performance: Development of Expertise in a Natural Task, Playing the Trombone." Conference Presentation also found in Bajpai, P.K. (Ed.) *Proceedings of the 15th Southern Biomedical Engineering Conference*. Piscataway, NJ: IEEE Publications.