On Musical Virtuosity

Justin London
Carleton College
Northfield, USA

What is Virtuosity?

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Virtuosity involves playing **REALLY FAST**.

Here is another example of virtuosity:

What is Virtuosity?

But just playing **REALLY FAST** is not enough:

What is Virtuosity?

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But they are not, alas, virtuosos.

What is Virtuosity?

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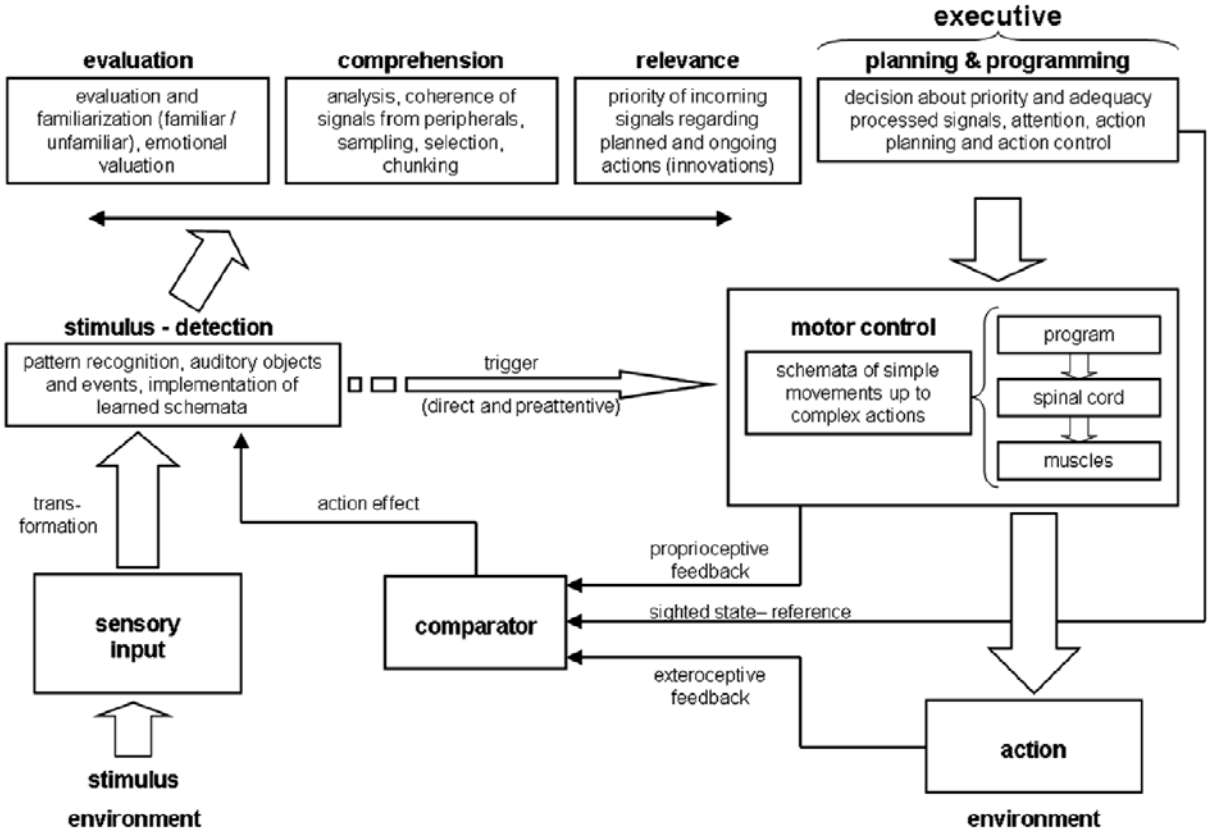
Yo-Yo Ma is a virtuoso cellist (of course!), but not every piece he plays exemplifies his virtuosity (though we might argue about that . . .).

What is Virtuosity?

- Virtuoso and control performances involve technical skill, characterized by speed and control (and at times, strength).
- Expressive performances also involve skill, albeit of a different kind (e.g., timing).
- Skill acquisition requires sustained effort and practice (the “10,000 hour rule”).
- Virtuosos do what most other musicians cannot, even those who have practiced a lot.

Motor Control in Musicians



Fischinger (2011)

Motor Control in Musicians

- How do we learn to do things?

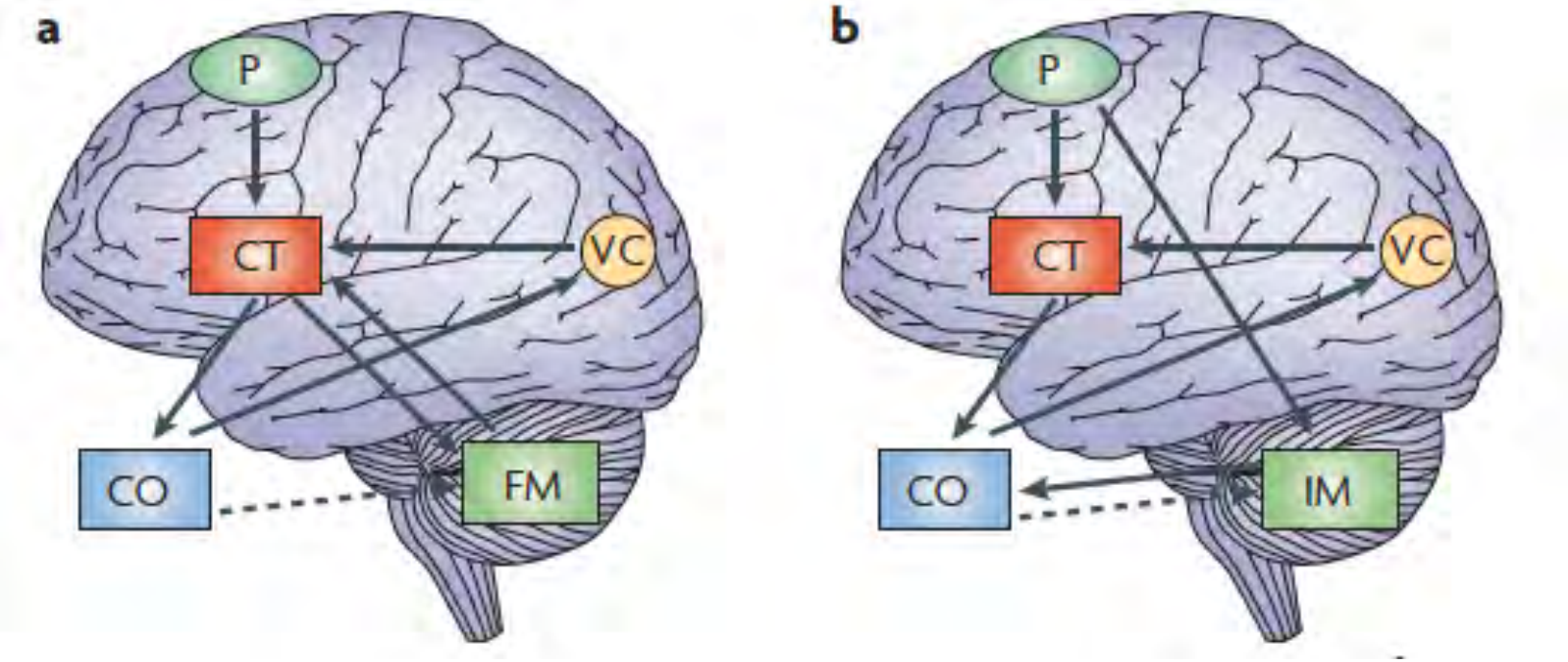
  Answer: practice, practice, practice
- Practice does require continuous control, skilled performance does not.
- How do we get from practice to performance?

Motor Control in Musicians

To form an adaptive control system — that is, a control system that can learn[105] — another element is required: an internal model. Two types of internal model have been proposed. A 'forward' model reproduces the dynamics of a controlled object, whereas an 'inverse' model reproduces a reciprocal of those dynamics. A forward model provides an internal feedback that can replace the external feedback from the controlled object (FIG. 2B). An inverse model, by contrast, provides a controller that does not receive feedback (a feed-forward controller), which can replace the original controller (FIG. 2C). These two types of internal model might operate in combination[6].

(Ito, 2008)

Motor Control in Musicians



Motor Control in Musicians

Musicians' brains are different:

- Increased development of the corpus callosum (Schlaug et al 1995, Steele et al 2013)
- Enhanced Working Memory & Attention (Oechslin et al 2013)
- Enhanced Executive Function/Task Switching (Zuk et al 2014)

The Limits to Virtuosity

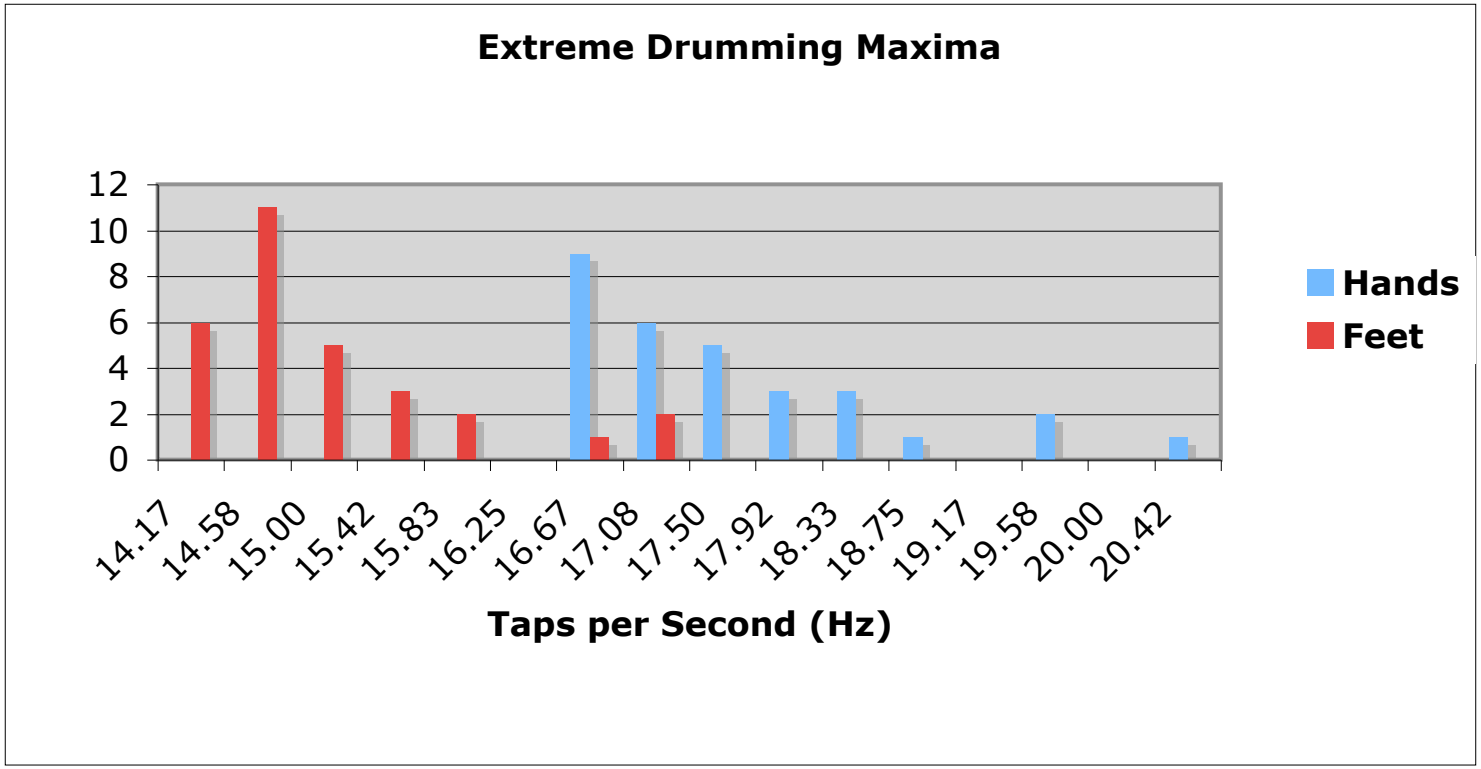
Virtuosity is constrained by basic limits on perception and motor behavior

The Limits to Virtuosity

"Extreme Drumming" nicely illustrates the sensorimotor limit for event production

- 10hz for timing of events (each individual hand)
- 20hz for event rate (Left-Right hand alternation)
- Mike Mangini (2005) 1203; Tom Grosset (2016) 1208 strokes in 60 seconds (= 20.13hz)

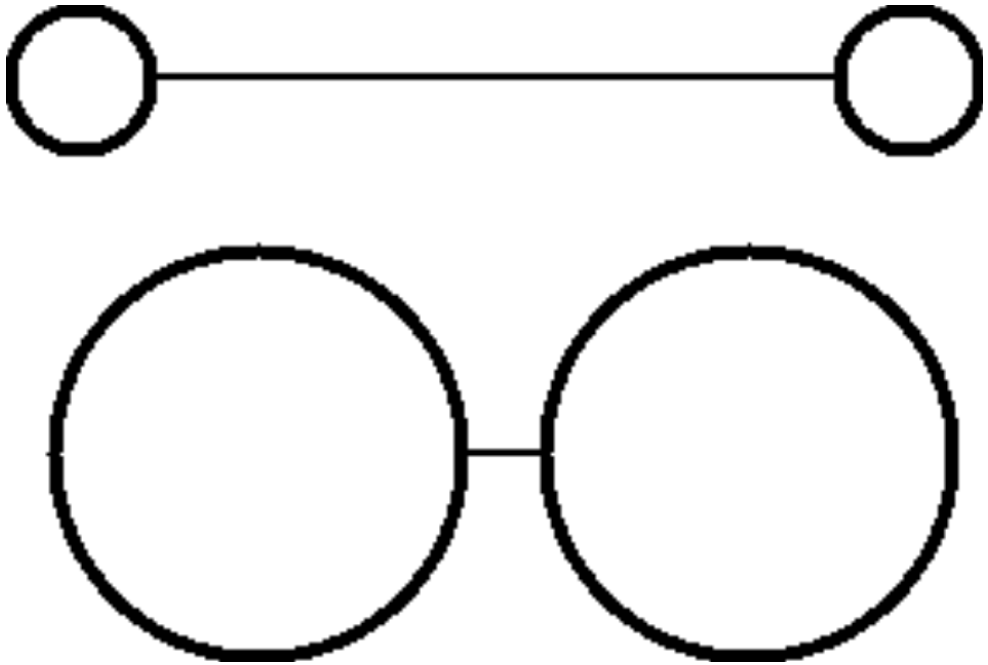
The Limits to Virtuosity



The Limits to Virtuosity

Other Constraints on complex behavior:

1. Fitts' Law



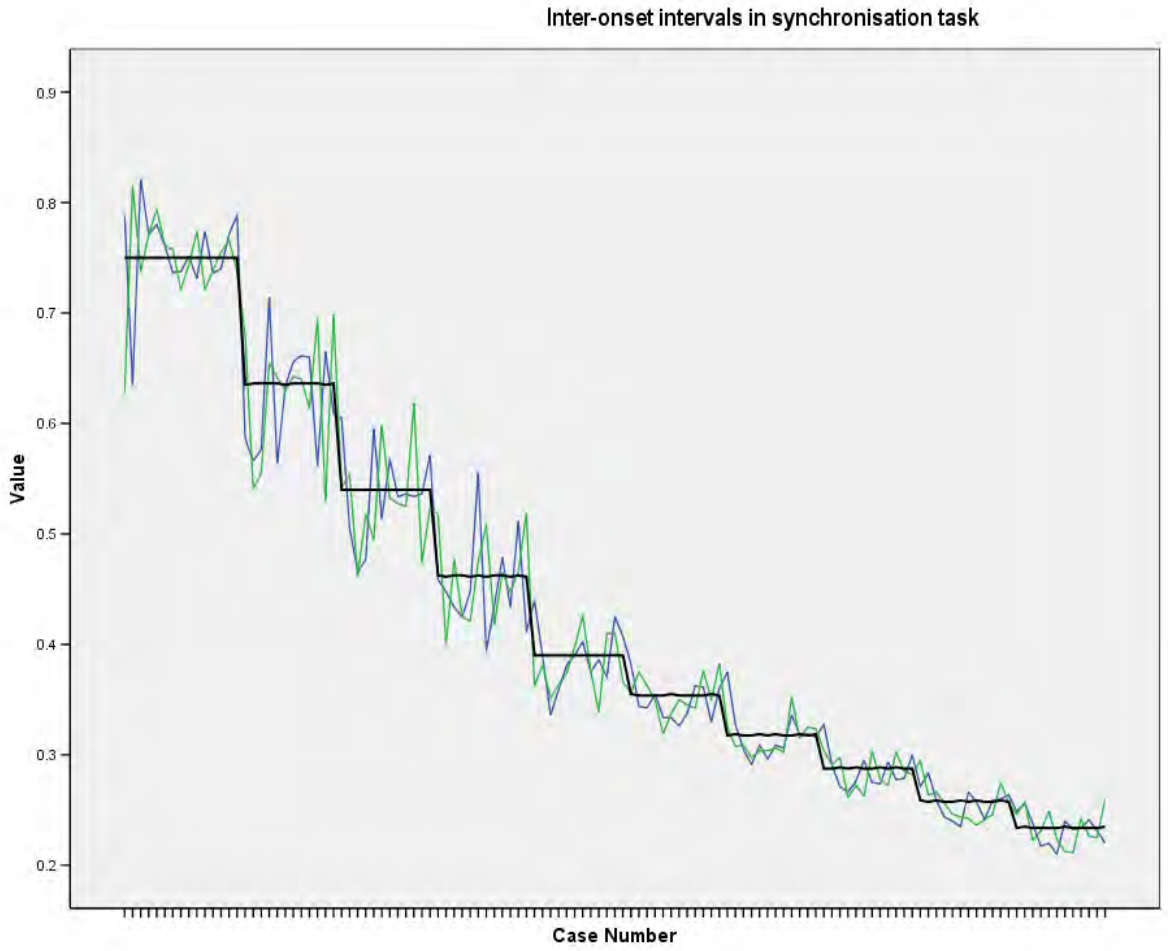
The Limits to Virtuosity

2. Hick-Hyman Law:

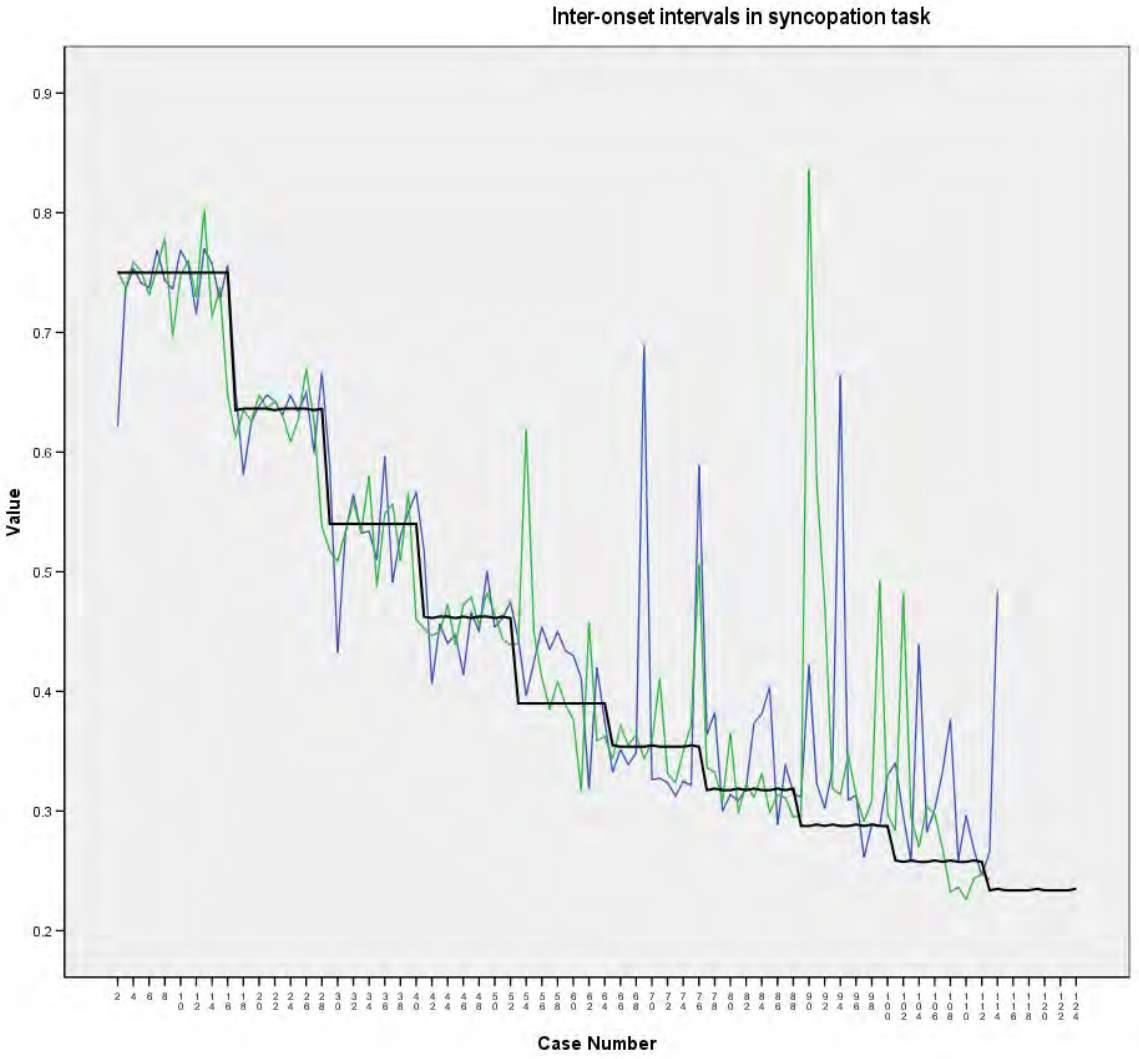
Reaction times/response times for are linked to the number of possible responses: the more possible actions (and hence decisions to be made), the slower one performs the task. Thus in addition to motor constraints, there are also cognitive processing constraints.

Music performance, especially ensemble and/or improvisatory performance, usually involves a combination of Fitts' and Hick-Hyman laws.

The Limits to Virtuosity



The Limits to Virtuosity



The Limits to Virtuosity

- Virtuosity is a solo art.
- Fastest speeds possible for a soloist are an order of magnitude faster than fastest speeds at which one can play together.
- This makes sense when one considers the added perceptual and motor control tasks involved
  - Ensemble performance requires both routes of the Dual-Route model, while solo performance mostly requires the pre-attentive, automatic route.

The Limits to Virtuosity

Nonetheless, complex and rapid coordination is possible:

Virtuoso Neurobiology

Virtuosos can play very fast . . .

- But they can't play faster than most skilled musicians;
- They can't play very fast with another virtuoso;
- They may or may not be able to learn new material faster than skilled musicians.

So what's so special about virtuosos?

Virtuoso Neurobiology

Answer: Virtuosos don't make mistakes

- A skilled violinist can play a Paganini caprice correctly most of the time, but a virtuoso gets it right almost all the time

Why?

Virtuoso Neurobiology

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Why?

Answer, and again related to limits of executive function:

- Virtuoso has a better, more independent inverse model than ordinary musician

Virtuoso Neurobiology

The executive functions of the brain are SLOOOW.

They have to be: they involve “looking before you leap,” invoking long-term memory, reconstruals of information, foreseeing future events, etc., etc.

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➔ Virtuosos avoid the speed traps of their pre-frontal cortices.

Virtuoso Neurobiology

Virtuosos have extremely well-honed motor programs (10,000 hour rule).

Hypothesis: Hyper-overlearned behaviors engender the “cognitive confidence” to be able to perform the task without any significant degree of executive monitoring.

Virtuoso Neurobiology

AND IF Virtuosity involves suppression of executive function (to some degree),

THEN this explains why Virtuosity is a solo art, for executive monitoring is what is required for the coordination of complex motor behaviors.

Virtuosity and Technology

- Virtuosity dependent upon technique that is the product of both talent and lots of practice.
- It is demonstrated in live performance, where there is the possibility of error.
- Recordings do not engage virtuosity in the same way, though these days most of our musical experience is via recordings.

Virtuosity and Technology

- The problem with recordings is one of transparency: do you hear what “really happened?”
- Most recordings are a composite of many different takes, with the mistakes edited out.
- Other enhancements also involved (auto-tuning, time shifting, etc.).

Virtuosity and Technology

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- We seek aural evidence (i.e., mistakes) that the “enabling technology” has been restrained.

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  Of course, this too can be faked.

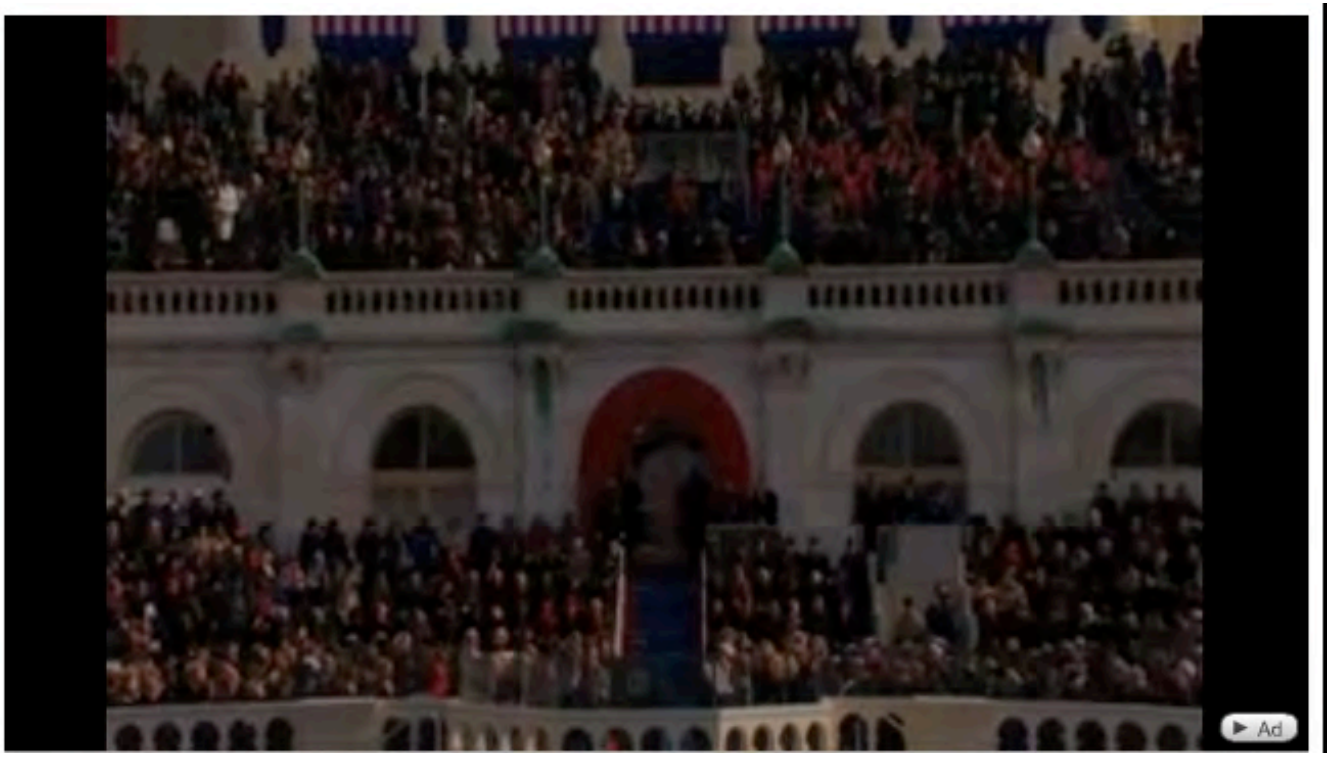
Virtuosity

Das Ende

Vielen Dank

Virtuosity and Technology

In other words, no cheating:



The Limits to Virtuosity

Fitts' Law states, simply, that for all goal-directed muscular activity there are trade-offs between distance, speed and accuracy. Huron (2001) relates this to the perception of melodic motion:

> "The brain is able to perceive apparent motion, only if the visual evidence is consistent with how motion occurs in the real world . . .In short, it may be that Fitts' law provides the origin for the common musical metaphor of "melodic motion."