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**From:** [REDACTED] on behalf of Ed Boyden <[REDACTED]>  
**Sent:** Tuesday, May 28, 2013 10:55 AM  
**To:** Jeffrey Epstein  
**Subject:** Re: Thanks

The piano itself isn't quite the analogy to the brain, because it has no memory, independent of the human playing it.  
After the finger lifts, the strings quiets down.

So I am assuming that we need to model the human playing the piano?

Suppose, say, we want to understand what emotion is generating the music.

If we could measure activity in the brain of the person playing the piano, and could predict what melody or sequence of notes the person would play, based on that activity, then we could infer that the internal brain activity was causing the melody. This inference might be convertible into proof, if we were to stimulate the brain and play back an activity pattern into the brain, seeing how that would alter the melody being played. And if we have a molecular map of the brain, which we could simulate on a computer, we could through biophysical simulation begin to see how the molecular interactions between cells, yield dynamics of the network, which then yield the sequence of finger commands that yield the music.

Thus, the finger is the interface between two dynamical systems -- the brain and the piano. Each of those dynamical systems has a physical implementation that can be modeled, if we have three things:

- mechanistic maps (piano: string lengths, material properties, etc.)
- dynamics (piano: the finger movements and temporal sculpting)
- control (piano: we can modulate the human and see how the music changes)

Ed

On Tue, May 28, 2013 at 6:46 AM, Jeffrey Epstein <jeevacation@gmail.com> wrote:

> give me a piano music analogy, / watching the strings, ? after key

> inputs,? interesting but not dispositive of anything meaningful

>

>

> On Tue, May 28, 2013 at 6:40 AM, Ed Boyden <[REDACTED]> wrote:

>>

>> I agree we need a top-down! Two thoughts:

>> -- Yes, developing mapping circuit technology and then applying it  
>> to simple behaviors -- hard wired aversive stuff -- is indeed a way  
>> to go. As we plan out these mapping technologies, we're actually  
>> beginning experiments to map out these aversive things too. We are  
>> collaborating with many groups along these lines. We need to finish  
>> the fundamental technology building so that we can obtain maps at the  
>> right level, and then we can acquire datasets that are compatible  
>> with top-down theory, to be sure.

>> -- Another way to think top-down is to work our way inwards, from  
>> the observables. We know that behavior -- movement, speech, other  
>> action

>> -- is observable; if a feeling or thought is prominent enough, it  
>> will be manifest through these channels as an observable. Thus we  
>> can also try to infer internal states by their effects on  
>> observables, and then to associate neural activity with these  
>> internal states and observables. In theory this should scale to

>> arbitrarily complex internal states, not just simple aversive states.  
>>  
>> Best,  
>> Ed  
>>  
>> On Thu, May 23, 2013 at 11:24 AM, Jeffrey Epstein  
>> <jeevacation@gmail.com>  
>> wrote:  
>>> i think you need a top down as well as bottom up. as looking at my  
>>> piano  
>>> while being played, i can go string by string ( not string theory  
>>> strings). hammer by hammer, material of string , molecular interaction  
>>> naturalvibration, harmonics, sympathtice vibration but i would not  
>>> hear  
>>> or understand the melody or music being played. I believe that each  
>>> individual has its own encrpytion algorithm, , as the neural net  
>>> grows  
>>> it encrypts some input signals. some are hard wired. so instead  
>>> of emotion , movement, speech, etc, I think a proitable area of  
>>> initail inquiry should  
>>> be the hard wired aversive stuff only. smell of dead meat. .  
>>> reaction  
>>> to fire. i tihnk that aesthectics will be the greatest ration of  
>>> output to  
>>> input. . or the least energy to decode. . dissonance, cannot be  
>>> easily  
>>> resolved so the energy to decode the information, is too high and  
>>> becomes  
>>> painful. Does a dream state come upon us, or do we dream all the  
>>> time  
>>> and concious state relegates the dreams to behind the screen. When  
>>> sleep  
>>> deprived the dreams begin to pop through the screen, as  
>>> hallucinations.  
>>> a breakdown of the screen , results in a form of schizophrenia,  
>>> where they cann no longer distiguish between voices. dream  
>>> produced while awake or the  
>>> awake state angel on the shoulder whispering. . I am an avid funder  
>>> of  
>>> the bleeding edge in many fields. keep me up to date on what you are  
>>> doing, and hope to see you in your own habitat.  
>>>  
>>>  
>>> On Thu, May 23, 2013 at 11:04 AM, Ed Boyden <[REDACTED]> wrote:  
>>>  
>>> Hi Jeffrey,  
>>>  
>>> Yes, it was great chatting about all the ways neuroengineering is  
>>> going to go in the coming years, revealing both fundamental  
>>> mechanistic brain maps, and providing the control knobs for fixing  
>>> brain disorders and understanding complex phenomena like  
>>> consciousness. Would be great to talk about how then to make

>>> mathematical sense of these maps and control knobs... arguably  
>>> the big stumbling block to date is the lack of good data, but  
>>> that's about to change, thanks to our current and future efforts!  
>>> Then we will have many things that require deep mathematics to understand!

>>>

>>> Ed

>>>

>>> On Thu, May 23, 2013 at 1:16 AM, Joi Ito <ji@media.mit.edu> wrote:

>>>> Hi Jeffrey.

>>>>

>>>> Thanks for a really enjoyable conversation and your hospitality  
>>>> tonight.

>>>> Look forward to connecting again and receiving you at the Media

>>>> Lab on my turf. ;-)

>>>>

>>>> - Joi

>>>>

>>>

>>>

>>>

>>> --

>>> Ed Boyden, Ph. D.

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>> --

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[REDACTED] <?xml version="1.0" encoding="UTF-8"?> <!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd">  
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    <integer>255311</integer>  
    <key>date-last-viewed</key>  
    <integer>0</integer>  
    <key>date-received</key>  
    <integer>1369738529</integer>  
    <key>flags</key>  
    <integer>8590195713</integer>  
    <key>gmail-label-ids</key>  
    <array>  
        <integer>6</integer>  
        <integer>2</integer>  
    </array>  
    <key>remote-id</key>

```
<string>305673</string>
</dict>
</plist>
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