

Appendix 6 - The Biomechanics of the Middle and Ring Fingers

Here is a more detailed anatomical picture of the picking hand middle and ring finger connections as it is understood at this time. This is written by Kelly Cole, who is a teacher and researcher at the University of Iowa. His combination of being passionate about both his profession and about being a bluegrass banjo player qualifies him perfectly here, especially as he changed his picking hand locating to a two finger plant after 25 years of locating with his little finger only. Results count, and he wrote "I couldn't be more pleased with the result: not only in timing, accuracy, and speed, but I pull a better sound out the banjo now." He did this in about 2 months by using Bill Evans' strategy as described in Section 7.

Although this may be heavy reading, it is worth working through. Margin notes or highlighting can help. If you wind up consulting with a doctor or physical therapist it may be helpful to them also. This is cutting edge stuff, and not all the medical community is aware of it. You may also want to consult a copy of Gray's Anatomy or other reference showing the muscles in the hand to understand this better. Ideally, understanding will lead to better decisions about your playing.

I need to comment here that I generate my picking force from the first two joints, sort of claw like, and don't have same interconnection problems as he talks about in either hand (I play both right and left handed). It underscores the need for careful personal experimentation and paying attention to your internal kinesthetic feedback, what comes of your anatomy and the sound produced.

There are probably some banjo players with variant anatomy who need to know that they may have unusually strong mechanical connections between the ring and middle extrinsic flexors. It is axiomatic that variations in nerve supply, blood supply, and muscle and tendon arrangement are common in the hand. So, I'll emphasize with caps:

IT MAY BE THAT NOT EVERYONE CAN PICK WELL WITH A TWO-FINGER PLANT

With that said I still want to emphasize that the phenomenon of middle-ring 'enslaving' has a large neural component, and many, if not most pickers would be able to switch. Put differently, much of the connection is often mental, and the programming can be altered.

In particular the connections between adjacent digits involving tendons and motor units (muscle fiber groupings) of the deep flexor (flexor digitorum profundus) have been well described and are pertinent here. They are very real and contribute to some of the 'enslaving' force. Despite this, recent work is pretty convincing that enslaving effects among different muscles suggest a widespread neural interaction among the structures controlling flexor muscles in the hand as the main mechanism of finger enslaving" (Zatsiorsky et al. "Enslaving effects in multi finger force production" *Experimental Brain Research* 131:187-195, 2000). These enslaving forces are significant and persist even after all extensor and flexor tendon interconnections are severed (Leijnse, *JNAL* "Measuring force transfers in the deep flexors of the musician's hand: theoretical analysis, clinical examples." *Journal of Biomechanics* 30:873-882, 1997). I suspect that the people who absolutely cannot switch after trying diligently are examples of individuals with substantial tendon sharing, or have other anatomical variations (which are not uncommon in the hand - I dissected a hand with two lumbrical muscles at each place where'd you normally find only one, and they went to adjacent digits.

So what is going on when we 'retrain'? The literature suggests that we learn to produce independent ring and middle finger motion by altering how we activate cerebral cortical cells, probably in primary motor cortex. Neurons in motor cortex don't make simple direct connections to individual muscles. We are set up to flex and extend our fingers together, and to grasp - independent digit movements outside of the index finger and thumb requires some complex neuron activation to yield the needed balance in muscle force at each joint). Completely independent digit motion is the result of a complex pattern of activation that isolates a movement by preventing other movements mechanically and perhaps by inhibiting some muscles as well. This is why it takes lots of repetitions to learn such skills. Learning new motor skills changes the way muscles and movements are represented topographically among the cells of the motor cortex, and also the way sensory information is represented in the sensory cortex (for a short review see Nudo, RJ "Recovery after damage to motor cortical areas" Current Opinion in Neurobiology, 9:740-747, 1999).

But that is not all. At least in me, even now there are strong linkages between the middle and ring fingers when I attempt to flex the middle finger at the distal (end) joints. This surely represents well-known mechanical linkages between the profundus muscle digitations for those two fingers at the level of both muscle and tendon.

I'm really taken with the idea that part of the retraining that happens when we switch from a pinky only to a ring plus pinky (2 finger) as I did it can involve learning how to produce the finger flexion for the picking stroke by using the flexor digitorum superficialis muscle a little more, and the flexor digitorum profundus a little less. There's more tendon sharing and motor unit mixing between the ring and middle finger digitations of the profundus than the superficialis. I'll let you know if I get around to testing this theory by recording muscle activity from these muscles in subjects just learning a two-finger plant.

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