

Technical Topic: Air Flow/ Speed/ Pressure in the mouth

Most texts are written by Darryl Jones on the Trumpet Herald (used with permission).

Tongue arch position can not add additional air pressure AT the aperture. It is the flow that occurs AT the aperture that will determine how much flow there is over the tongue. This flow AT the aperture is determined by the pressure AT the aperture and the pressure encountered AT the aperture.

The air speed is the primary determinate of dynamic level, because for a given frequency, an increase in air speed implies an increase in amplitude which means things become louder.

Frequency or pitch, depends on the speed of oscillation of the vibration source. So this means that a greater amount of tension/firmness in the lips causes an increase in frequency.

Now I'm wondering how this whole tongue arch thing fits in.

If the lips are vibrating, does a decrease in the buzzing area affect pitch? e.g. In the case of the string, if only half the string is vibrating the pitch goes up. So if the buzzing area on the lips is reduced, does the analogy to the string hold, causing a upward change in pitch?

I may be missing the point, but it seems that for the last few pages you guys have been arguing over the affects of the tongue arch on air speed and air pressure. What are the effects of air pressure on range? If the lips are set at a certain tension, what is the effect of pressure on the pitch produced? A few pages back, you said that $F = P \times A$, where F is force, P is pressure and A is area. So an increase in pressure is an increase in force, so what part does this play on tone production? What is the analogy here?

Ok, last question. Is air flow subject to Boyle's law on pressure? If we pressurize the air stream with the lungs behind the tongue and then release it, does this increase the pressure of the air and thereby, the force of the air?

Resistance encountered at the aperture is due to multiple factors.

Primary ones are:

- the air resistance of the small aperture opening
- the acoustic back-pressure from the mouthpiece cup while playing a note

In other words, the air pressure of the "open" aperture is exposed to greater than ambient (atmospheric) pressure.

So the air resistance encountered is actually more than the aperture average size into ambient pressure.

Since the average size of the aperture opening is smaller for higher pitches at a given volume, a slight increase in resistance is observed as one ascends over substantial intervals.

I am not convinced that the firmness of the lips will contribute to resistance in an appreciable way. Mostly just the size and the cup-pressure encountered.

Quote:

The air speed is the primary determinate of dynamic level, because for a given frequency, an increase in air speed implies an increase in amplitude which means things become louder.

Not exactly, the speed at any point depends on two things, flow and cross-sectional area.

The volume is determined by the maximum (or "peak") pressure, of the resonant wave inside the horn. The mouth MUST supply AT LEAST this air-pressure at the aperture entering the cup.

(However, the mouth pressure will need to be higher due to simple flow-resistance losses thru the aperture)

The mouthpiece throat provides an acoustic resistance point, allowing the mouth pressure to "pump-up" the cup pressure to the desired peak pressure for the desired volume. (This happens on the "open" swing of the aperture oscillation.)

However, air must flow into the cup for this "pump-up" to occur and add energy to the reflected wave in the horn.

How much **flow** will depend on the acoustic characteristics of the horn and mouthpiece.

So you should see that air-pressure is what determines sound volume and a flow will result based on the equipment's acoustics. You could then compute air velocity (or speed) for any point in the system by dividing the flow by the area.

So speed does not determine volume but is a "consequence" or "result of it" but even then it varies infinitely at different points along the path.

Frequency or pitch, depends on the speed of oscillation of the vibration source. So this means that a greater amount of tension/firmness in the lips causes an increase in frequency.

Yes, but a reduction in the size of the vibrating area will cause an increase as well. But these are general observations, that are analogous to a string on a stringed instrument.

If the lips are set at a certain tension, what is the effect of pressure on the pitch produced?

Pressure will not determine pitch, only volume as I explained above.

However there must be sufficient pressure to "deflect" the tissues outward/upward (or downward) so that the pressure can be exposed to the cup, however this need not be much for soft notes.

It could be argued that the deflection force required is greater for a more firmer embouchure, and I believe this to be the case.

Please note that greater pressure from the mouth will increase the deflection of the aperture opening. But it is really not the vibrating lips that are giving energy to the sound in the horn. It is the cycling air pressure and resulting applied air power which is giving that energy to the wave in the horn as explained above.

It has been said that the horn "amplifies" the vibration of the lips, but that is really not an accurate description.

Is air flow subject to Boyle's law on pressure? If we pressurize the air stream with the lungs behind the tongue and then release it, does this increase the pressure of the air and thereby, the force of the air?

No, the force of the air is directly related to pressure, and even then, force can only be determined for a known area.

It does no real service to try to discuss the FORCE of the air in this context. Pressure and force are not the same thing.

You do not further pressurize the air simply because you reduced the area of it's flow.

therefore

$$V_2 = \text{square root of } [2(P_1 - P_2)/r]$$

So you can see that the speed thru the aperture is determined by the Pressure difference primarily. Especially since the air velocity is considerably larger than that air thru the mouth.

If you wanted to consider the pressure resistance due to the acoustic back-pressure of the horn, You could model the problem with an even smaller A_2 as to add to the resistance encountered into ambient pressure. This would even further re-enforce the assumption that V_2 is much greater than V_1 .

Part of the problem of perception in the trumpet community is that the air "zips" through the mouth as some high velocity, on the order of what goes thru the aperture.

It doesn't.

The air **does** go quite fast thru the aperture since this area is quite small.

Another misconception is the idea that an arch in the back of the mouth will cause a loss of air energy but one near the aperture will increase it. Well it is easy to see that this is false. As any arch begins to become near in size to the size of the opening in the aperture, a loss of pressure is realized regardless of **where** the arch is.

There is no "intentional misrepresentation". There may be exaggeration in the interests of simplicity, but when people are suggesting something that breaks the most fundamental laws of physics, perhaps that can be forgiven.

As I say, play with the changeable any way you like, but make sure in your comparisons you keep the final width (the aperture) constant. If you say the difference with the tongue arch is that it "funnels" the air, thus speeding it up I invite you to compare the velocity at the aperture for the following shapes:

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Your representation of the tongue arch.

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My representation of the same aperture size, but without the tongue arch.

The velocity at the aperture will be the same for each.

<http://home.earthlink.net/~mmc1919/venturi.html>

Also, when you read Claude Gordon's "Brass playing is no harder than deep breathing" book, he has a very good section on the tongue. He says that the only way to change the pitch is by tongue level.

Now I'm sure many of you are quick to disagree, but to me it makes sense.

Unless you change the lips they will not vibrate at a different pitch, this change need not be visible or even require perceptible movement, but the muscular action around the chops to change the firmness, shape, size, point of vibration etc. Can not be attributed to tongue movement alone.

Also, I can hold a pitch with the embouchure muscles set while moving the tongue up and down inside the mouth. So it is quite easy to demonstrate that Gordon's statement is false.

He continues to say that many people think you play higher by blowing harder or doing something with the air. He says that if you lock your tongue into place and have its level not change (it's hard to do!) then you can not change the note.

It IS hard to use the embouchure muscles if you "lock - down" your tongue because of the physiological connection.

He also says that no sort of lip movement or tension can change the pitch either. It's all in the tongue.

Again, that would be like saying that changing the length or tension of a vibrating string would not change its pitch. And,.. it is also completely false.

The way I think of it is that the tongue creates the proper resistance for each note, and then the strong air force going through that resistance and then flowing faster creates the higher pitch.

You must realize that ANY resistance added in the mouth will dissipate the air energy before it reaches the aperture, lowering its pressure, this would not EVER be desirable for an efficient player.

Air speed is not the causative factor of pitch, again, easily dismissed since there can be a vast number of different speeds on a pitch across changing dynamics.

That's why it feels like you have to blow harder for higher notes, the tongue arch creates a higher resistance.

For normal tongue arch, no perceptible resistance is added. But if the arch is so high that the air-way "approaches" the size of the aperture, then it will create resistance, and in-turn, rob the air of its energy (pressure) before it reaches the embouchure.

You can see the tongue is what determines the pitch of the voice, so why should it be any different for the trumpet?

As was already show, how in error this line of thinking is.

Yes, the lips are involved, but really that doesn't mean much. They are just a vibrating medium for the small air stream the flows throw them. Focusing on tense lips really just gives you a bad sound from what I can see.

Yes, the lips ARE the vibrating medium, you got that right. And any vibrating medium's frequency is determined BY that medium. Not the amount of energy that is making it vibrate. That is related to the INTENSITY of that vibration. Not the frequency.

It seems that the same old erroneous arguments are being attempted here, each one generally flawed but that's OK. It is difficult to understand air dynamics since it is quite a slippery subject.

One misunderstood point is that the air is "accelerated" when the path is narrowed for an iso-pressure path. But actually there is no NET acceleration of the flow. The increase in velocity is due to the conservation of mass-flow and a reduced cross section.

The mistake is made that just because the air particles are moving faster, energy is increased in the

net flow. It is not, of any significance, in this case. How fast the air moves thru the aperture will depend on the difference in pressure, as I have already shown mathematically.

(Talk of a tornado is a stretch because it is just not the same problem.)

But for a constant width pipe, a "drop" in pressure WILL accelerate the particles and no narrowing is required. But, the amount of pressure drop determines the maximum velocity increase. (The ACTUAL velocity increase is considerably less)

I have shown, mathematically why the pressure difference ALONE will determine the maximum velocity thru an aperture.

The math is based on Bernoulli's Laws, which is accepted by the scientific community and experimentally verifiable.

Now, if the mathematical analysis is in error, anyone is welcome to point out what and/or why.

So if one wishes to increase the air velocity thru the aperture, or the air pressure available there, he must increase pressure from the body. Specifically, the lungs.

No amount of lip tension or "lung pressure" will change the pitch without the tongue moving.

You are right about the lung pressure, that is related more to sound volume.

However for the act of setting the lips correctly, most people execute a certain amount of muscular effort from just inside of the mouth. These muscles, around the inside of the bottom lip, can not move freely unless the tongue reacts and moves forward and up, allowing the tissue to move forward. Also the muscles at the corners can cause a reaction from the tongue. Perhaps Gordon was trying to get his students to use **these** embouchure muscles but concentrate on the tongue movement "alone" so they would not think about the lips.

However, it IS possible to use the type of embouchure where more of the outer tissues of the mouth are used for tensioning, (rolling-in type). These muscles are not connected physiologically to the tongue so the tongue does not react.

Personally my embouchure is a little bit of both, so my tongue moves up very little in response to the little bit of effort from inside the aperture.

Even so that I can play quite high with a low tongue. And it sounds good! And I get the advantage of the absence of an extremely arched tongue robbing me of air pressure at the aperture.

But I have learned to set the embouchure in a variety of ways depending on the sound I want and other factors. Because the embouchure determines the pitch and influences the tone, the tongue may "react" to how you are actively using the muscles near the embouchure by resting "up, mid or down" but this does not influence the sound. And , again, as I have shown, it does not influence pressure at the aperture or speed through the aperture other than to possibly impede both.

I don't normally like getting involved in these kinds of discussions but surely we a trying to simplify the processes for players, not to add to the abundance of misinformation and confusion that already exists.

Actually, saying that tongue movement is "required" to speed up the air for higher pitches is the grossest of mis-information. It should never be taught that the tongue "**must** stay low" or that it "**must** move up". ESPECIALLY if either of those concepts were attempted to be reinforced by junk science as a means of "enforcing" them.

Find a natural way to play, with the minimum effort and movement possible, that's **my** philosophy. The air **velocity** "over" the arch IS faster if the arch reduces the cross-sectional area of flow. I NEVER said otherwise.

But the difference in pressure is what determines the air velocity thru the aperture, and the approaching air speed can not favorably influence that in this case.

And the net flow IS of consequence, you see, for each air particle that increases in speed there is one that is diminished by the same amount.

Yet you want to ONLY include those which speed-up. You can NOT attempt to correctly and accurately discuss air dynamics using particle dynamic principles. Sorry.

For the system, a "flow" will occur based on the pressure difference and the size of the aperture (excluding ANY resistive or frictional effects). (and trust me Tom, you dont want to bring them into the analysis because it will work against you)

This "flow" or, volume per time, is the same EVERYWHERE along the path.

Now, you can raise the tongue to a position that will reduce the area, but the "flow" will still be the same. And the "flow" is determined by the embouchure and the pressure applied. SO for a given area the "speed" could be determined as well.

So regardless of where the arch is, neglecting friction, the speed over the arch is determined by the embouchure and the applied pressure, not arch position.

And again, any speed additional speed attained over the tongue will not increase the pressure in this case, as is shown by Bernoulli's scientifically correct and experimentally verifiable principles.

No-one gave any suggestions as far as my singing comments on the previous page go, and I would also like to add whistling into the discussion. It is absolutely undeniable that the tongue changes the pitch when whistling. I fear that a whole new set of scientific speak is going to appear.

Mainly because I am not sure what you were trying to say about the singing. Because the oral size has nothing to do with pitch, only color. Similar to how the bell or bell/mute colors the trumpet sound.

The reason that the tongue changes the pitch while whistling has nothing to do with trumpet playing.

In whistling, the resonant frequency is directly related to the mouth size because it is a Helmholtz type resonance. Just as the length of the horn determines the resonance frequency when playing.

In Helmholtz resonance only one fundamental is allowed because it is not a standing wave like in a tube, in a tube there can be harmonics that are dominant.

The resonance when playing ends at the "closed" end of the pipe. There is no need or requirement for resonance to continue, it is de-coupled at the mouthpiece.

What is required for playing is a vibrating aperture with applied air pressure.

The size of the orifice behind the aperture does not favorably influence the pressure applied by the lungs or color the sound in any way.

The air column beyond the mouthpiece is what colors the sound apart from the vibrational characteristics of the aperture. Which not only determine the fundamental but influence the harmonics present by its behavior.

If one attempts to change the size and shape of the mouth it **is** possible that the embouchure setting could be minimally , if not drastically effected, thus changing the sound. But even then the actual SIZE has nothing to do with it.

Quote

The size of the orifice behind the aperture does not...color the sound in any way.

If you mean by that, as I think you do, the size of the (oral) Helmholtz resonator, just a few moments' personal experimentation should be all that would be necessary to disabuse you of that notion.

No, read carefully. When playing, the horn provides all the resonance that is needed. And for resonance to stand in it, the open end must be at ambient pressure.

Helmholtz whistling is where there is chamber and a tube of a length open to the atmosphere of ambient pressure.

They are two different phenomenon, and the Helmholtz conditions no longer exist for the mouth once you introduce a vibrating aperture and a varying air pressure external to the lips.

People have tried to assert that the resonant frequency of the mouth much match that of the horn for proper playing. Of course that is of no consequence in reality.

If you mean by that, as I think you do, the size of the (oral) Helmholtz resonator, just a few moments' personal experimentation should be all that would be necessary to disabuse you of that notion.

If you are suggesting that changing the size of the mouth while playing; it is possible to change it and observe no change in tone color, takes much coordination to do this and not disturb the embouchure setting. Most people when attempting to drastically change the size of the oral cavity while playing will distort the embouchure to the point that it will cause a change in the sound quality and/or intonation. Then they will try to attribute the change to the orifice size alone.

If you could distort the embouchure in the same way while holding the size constant you would get the same result.

There is no resonance in the mouth that is of any pressure variance on the order of that in the mp cup. And if there were it would be impossible to match the frequencies, and even then it would be detrimental to playing.

Try this: while playing a long note -- let's say, a g in the staff -- change the timbre from rich orchestral to sizzling lead and back. Analyze how you did it. Do you really believe all that change came from the embouchure and not by changing the size or shape of the oral cavity/throat

Timbre, or "sizzle" as you call it is related to volume in a more direct way.

And the sound of orchestral vs jazz is also dependent on the equipment or "coloring of sound" by the equipment used .

But for a set volume, changing the oral size will have no effect unless the embouchure is effected.

Harmonics are determined by the "wave shape" if you will, of the vibrating aperture.

And that "wave shape" is effected by the vibrational characteristics of the aperture.

The reason players make the mistake of believing that oral size alone colors the sound is that they do not recognize or consider the contributions due to volume change or embouchure change, and then engage in poor "cause and effect" thinking.

Check out this article by Thomas Moore (physicist, trumpet physics researcher)

<http://www.trumpetguild.org/pdf/2003journal/0306science.pdf>

He also makes some interesting statements about the science topic in general.

With regard to the effect of mouth/airway size and shape, Renold Schilke describes an interesting phenomenon as follows: "A good example of this occurred when Mr. Arnold Jacobs and Mr. A. Hirada of Japan were in my studio trying tubas. To obtain the same pitch, Mr. Jacobs had to have his slide all the way in, making the instrument on the extremely sharp side as his oral cavity was of such a tremendous size it lowered the pitch to the given pitch. However, Mr. Hirada, whose oral cavity is very small, had to pull his turning slide to give approximately eight additional inches of tubing to the instrument in order to play in the same pitch."

While this is about the mouth cavity's effect upon pitch, and not timbre, it confirms that the size/shape of the oral cavity does affect what's coming out the bell.

The Schilke experiment, which was poorly formulated, is effectively de-bunked here by Thomas Moore PHD.

<http://www.trumpetguild.org/pdf/2002journal/0203science.pdf>

I once believed that the oral cavity size alone dominantly affected the sound timbre and tuning. I believed it fervently. But thru some honest experience and observance, and some better scientific knowledge of the system, I was led to believe otherwise. Especially effects due to any kind of "Resonance" inside the mouth.

Also sound waves above double high g? Charles asked about at what point is the standing wave no longer existent.

The premise is that there are no resonances above high G and thus no standing waves.

Well, mathematically there are, for the open horn:

low C=2/2 full wavelengths in the horn

G=3/2

C=4/2

E=5/2

G=6/2 (notice this is 2 x 3/2 , an octave of the previous G)

7/2 - (not on the scale but between A and B flat)

high C = 8/2 (or 4 full wavelengths inside the horn)

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.
.

high G = 12/2

then there are these resonances:

13/2 - (undefined on scale but between G sharp and A)

14/2 (between A and B flat, as its 7/2 octave below)

15/2

16/2 (Double C, 8 full wavelengths in the horn)

Every successive wave length going up from a low C is weaker and less defined than the previous, while becoming closer together on the musical scale, such that the ones above G are so weakly defined that the fundamental frequency defined by the embouchure (if you can play up there) is what dominates the pitch.

But, if there is a note to be heard above high G then there IS a fundamental frequency AND a standing wave in the horn, in spite of the fact that the resonance peaks are very weakly defined.

Thus the difficulty of this range.

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He also makes some interesting statements about the science topic in general.

Good article. Also check out this one by Arthur H. Benade:

<http://joeleymard.free.fr/Benade/BenadePWW.htm>

Do you have any views on whether turbulence plays a role within the mouth?

The air moves through the mouth quite slowly. SO I don't think there is any significant turbulence that is detrimental. But if one raises the tongue extremely high in the mouth on a loud note the frictional effects of the air include turbulence, and pressure will drop some, but not more than what can be added back from the lungs to restore it.

I have not seen any studies on it though, specific to playing.

The air speed changes as it move from the lungs to the end of the bell. Even though the flow (not the volume) is the same in every part.

Which of those speeds, do you think, determine the pitch?

Or, shall we ask, where in the air path do you think that the air speed determines the frequency at which the aperture pulsates the air into the mouthpiece?

I think the air path that determines frequency resides in the oral cavity

You mean air speed in the cavity?

Do you believe air speed in the cavity is what determines frequency while whistling?

But it is the rate at which the aperture opens and closes , or "pulses" that determines the frequency of the pitch.

How, do you believe, that the speed of the air before it reaches that point can affect the frequency there?

Quote: *Do you believe air speed in the cavity is what determines frequency while whistling?*

Not specifically, however air speed in the cavity is directly proportional to air speed at the aperture, therefore adjusting the speed of the air in the cavity will alter the speed of the air at the aperture thus changing the pitch.

Absolutely not true. The air speeds are proportional only if you change the flow and leave all flow boundaries, such as the oral space, the same.

Increasing the air speed thru the mouth by making the oral space smaller does not increase the flow. And therefore, if the embouchure is still the same so will be the speed of the air thru it.

(As a matter of fact, all things being equal, any reduction in the path ANYWHERE will increase the total resistance and reduce the flow, and thereby, reduce the air speed thru the embouchure.)

Also, if what you wrote was true, you would not be able to change volumes without the pitch making significant changes. Because more sound volume requires more flow there would be, proportionally, an increase in speed of the air and therefore a change in pitch. Which, of course, does not happen.

Quote: *But it is the rate at which the aperture opens and closes , or "pulses" that determines the frequency of the pitch.*

The aperture doesn't close and open, it vibrates or (my preferred term) oscillates.

The aperture does oscillate between an open and (nearly)closed state. This periodically varies the pressure being applied to the mp cup.

It is not the "vibration" of the lips that gives energy to the sound in the trumpet. It is the air pressure variations caused by the alternating open/closed aperture exposing/denying the pressure from the mouth to the cup.

Quote: *How, do you believe, that the speed of the air before it reaches that point can affect the frequency there?*

As I wrote above, it's proportional.

Then, again, increasing the flow would also increase the pitch. Which does not happen.

Your line of thinking is not correct. If you increase or decrease the approaching path and achieve different speeds thru THAT segment, that does not mean that the flow is changed, or, speeds are increased in other non-changing segments.

So reducing the oral path size does not increase flow (it can only decrease it) nor does it change the speed of the air thru the aperture (it can only decrease it).

Quote: *And, again, do you believe there is a unique tongue level for each different pitch?*

Not unique, (obviously there are a number of things that can alter the pitch of the note, not all of them useful)

Actually there is only one way to change the pitch of a note, and that is to change the frequency that the embouchure oscillates. And that is achieved by changing THE embouchure.

Yes, most players do engage the tongue in assisting this process (consciously or not), as they also change the jaw position, teeth position and mouth floor (which is the actual reason that the tongue moves). But it has nothing to do with air speed. Anywhere!

Once the flow is established the average air speed varies by path width.

Air speed is EXTREMELY un-important and inconsequential to playing.

Air speed CAN be used in the context of feel or visualization as Eric pointed out. But it should be qualified as such by teachers AND students, who otherwise have NO IDEA what they are talking about.

In short, the pitch rises as embouchure muscle tension increases in resistance to increase in air pressure.....just like the 'ol balloon squeal .

It is more than simply tension. We physically adjust the limits of the part that vibrates WHILE we make the area just a bit more firm by tensing the muscles.

Or to compare to a vibrating string (only for analogy) we are mostly "shortening" the string rather than increasing the tension exclusively.

And your resistance explanation is backwards. We increase the pressure to maintain flow thru a smaller, more resistive aperture. AND we increase pressure to make-up for lost pressure thru a smaller aperture, also due the greater resistance of a smaller aperture.

Quote: *The difference in speed of air as it strikes the aperture is what causes an increase in pitch.*

This reveals your confusion with the subject of air science.

stay with me now...

The speed of the air molecules that come in contact with the lips, that is, molecular velocity, depends on one thing, and that is, **pressure**.

The net "speed" of the air that comes in contact with ANY boundary is ZERO. It is not the speed of the air thru the oral cavity (which itself varies)

Also, the air going **thru** the aperture opening is already MUCH faster that what the average speed is going thru the oral space. Even for an "eee" arch.

You believe that the air "strikes" the aperture with more energy because you reduced the section of the oral cavity.

But..

We actually know that for every increase in air velocity there is an equal drop in air static pressure. So even if you did increase the kinetic energy of the air, you reduced its potential energy by the same amount.

So, at best, (neglecting friction/viscosity) the air "strikes" the aperture the same way. Regardless of the size of the oral space or the speed over the arch.

However, if you do NOT neglect the frictional effect of faster air, Which is the case when we are playing, you will LOSE energy thru a pronounced arch, and the air will strike the aperture with not more energy or molecular speed, but, in fact, less.

Quote: *Try an experiment. Get a piece of flexible pipe about an inch and a half in diameter and about three to four feet in length. Hold one end in one hand and whirl it around your head. It should produce a note. Whirl it faster and the note will rise by a fifth.*

That is a flute, or a whistle. No comparison.

Quote: *No offense meant here, but it is just kind of tiring when people just have to put down others for not knowing every scientific fact of trumpet playing.*

I think you miss the point.

I am not putting down anyone.

I am just challenging their bogus explanations of WHY or HOW things work which is 180 degrees

from truth.

The false claims made about tongue arch and air speed can lead a developing player into bad habits of over-using the technique, and never developing an efficiency of playing before they are ingrained with bad habits of over-use.

And many players miss out on the opportunity to gain efficiency by lessening the arch action over time and development, rather than buying that there is a distinct tongue level, always, for each pitch. And developing that habit permanently.

Jake wrote:

Quote: *Really, do you think all the pros and big name players out there know all of this or care to study all the physics of playing? I doubt they know.*

No they do not. But it does not stop MANY of them from making claims and explanations, OF PHYSICS, that just simply are not true.

Is the subject of physics necessary to play well? No.

So then, is the introduction of "bad" physics and "junk" science necessary to play well? Absolutely not!

Yet the playing/ teaching community is rampant with bogus and bad information that IS counter-productive and could lead to inefficient playing.

But they have to teach something, and they feel they have to pretend to "know", and in many cases they do the student a major disservice.

To me the best teachers teach: action(or non-action) - sound - and then adjustment. No need for scientific explanations on a subject which they are ignorant about.

Darryl Jones