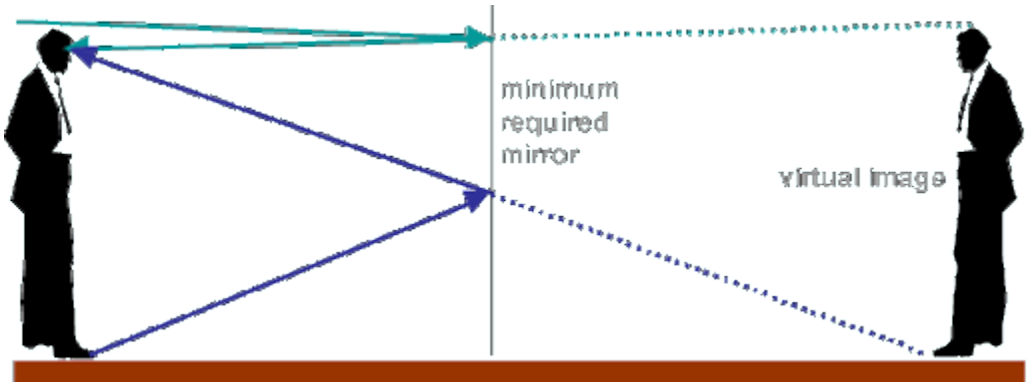
The Target Is Not Round and Bigger is Not Always Better

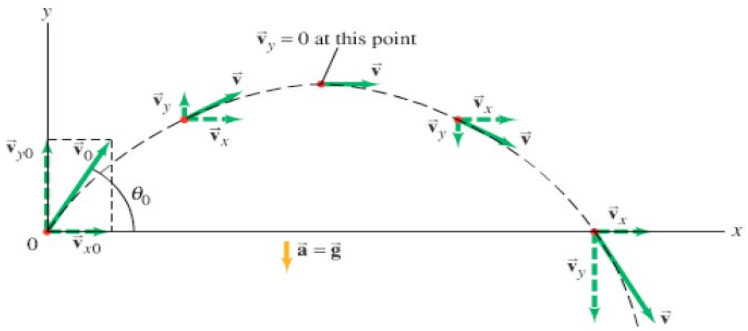
For those of us who shoot Highpower matches we all have stared at a lot of different targets. SR, SR3, MR63, MR65, MR, LR, etc. While the rings are the same one thing we would say they all have in common is that the targets are round and from what we see with our eye that is true. But if we were to talk to the bullet and some people do (we will leave further detail on this for a psychiatric article) the bullet would say it isn't round, and the bullet would be correct. Why is this?

When we look at a target we are looking at it perpindicular to the plane so we see it as round. This is because the light bounces off the target enters our eye and our brain interprets this data and we see the image.



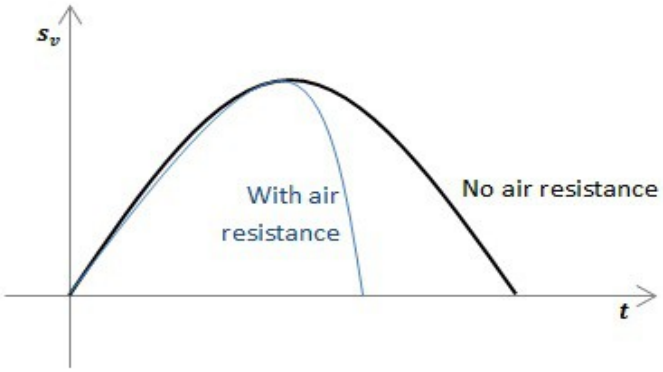
(please ignore the image on the right side does not apply as we are not talking about mirrors) How if you were to take an image and instead of having it straight in front of you you raise or lower it you will notice that the horizontal size doesn't change, BUT the vertical does. Without turning this into a complete optical physics lesson this is due to how the reflection angles above change and cause the image of the object to shrink even though it actually doesn't. In other words where the teal and purple lines meet on the wall that distance will get closer. This is exactly what the bullet sees. Now why is this? The angle at which the bullet hits the target and velocity error. This is the very same reason you hear Palma shooters talk about how easily a 155 gun holds vertical or the F-T/R shooters talk about how they had to really tune their 200X bullets because of vertical. The both are correct and it is because of good old Mr. Newton.

Before we begin we need to understand some basics. In a perfect physics world projectiles fly in a parabolic motion and from the side it looks like this.



In perfect physics world there is no resistive force in the horizontal dimension, therefore the horizontal component of the velocity remains the same. In the vertical dimension gravity decreases the vertical component of the velocity as it goes up. When it reaches the apex the vertical component is zero, and then gravity starts to accelerate it downward again. In perfect physics world the vertical components are the same at the beginning and the end of flight in magnitude but opposite in direction.

Now we don't live in a perfect physics world. We have air resistance. Because of this the horizontal component of velocity does change and thus the shape is not a perfect parabola. Once the projectile reaches zero vertical velocity the next part of the trajectory is rather condensed horizontally.



It is because of this that targets end up not being completely round. Depending on how round your target is, really depends on your bullet.

For this demonstration we are going to use Berger bullets for the simple reason they have the similar shape for a variety of calibers and weights and this will eliminate a variable. Comparing a 2156 Sierra to a 168 Hybird in .30cal with a 108gr ELD in 6mm would introduce the variables of bullets having different nose radius . By using the Hybrids we are able to keep this all consistent as the bullets all have the same profile. There are two exceptions to this aswe used the 200-20X bullet and the 90VLD.

For this demonstration we are going to use the online ballistic calculator JBM. But we are going to use it a little differently. We are going to uncheck the box so we can set the elevation of the rifle (think artillery). The following average speeds were used and as a result we found the following angles of elevation in MOA for 0.0" drop at 1000yd.

Bullet	avg (fps)	elevation (MOA)
155 hyb	3100	28.31
168 Hyb	2920	31.05
185 Hyb	2750	33.84
200x	2620	35.56

The velocities chosen are averages from approximately where people shoot these bullets in 1000yd competition. Some may go faster some may go slower, but these are near maximum pressure velocities and allow for a meaningful comparison.

As you can see the heavier bullet going slower requires more elevation. This is what we would expect. For those of use who shoot Any and Palma rifle or F-Open and F-T/R know that faster is flatter, and when going to a bigger caliber with a slower bullet you have to "dial-up".

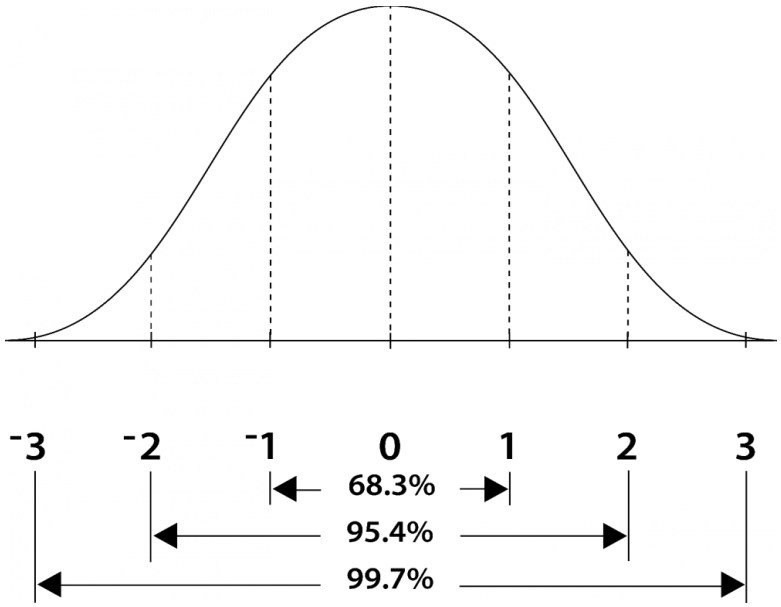
In sling competition our LR target is 1 MOA, 10" X ring, 20" 10 ring. So first thing we are going to look at is if we hold the rifle at perfect elevation how much can the speed differ and still land in the 10 ring. This is where the first interesting thing shows up. For this we adjusted the speed till the drop

at 1000yd was either -5” or +5”

Bullet	avg (fps)	elevation (MOA)	low x (FPS)	high X (fPS)	Range
155 hyb	3100	28.31	3077	3123	46
168 Hyb	2920	31.05	2905	2940	35
185 Hyb	2750	33.84	2733	2767	34
200x	2620	35.56	2604	2634	30

As you can see the 155 has a 46fps range, while the 200 has a 30fps range. We would all hope that our ammo is loaded better than this. If you split that in half you see with a 155gr bullet your speed can be 23fps above or below your average, while the 200X it can be 15fps each way. As long as everything else stays the same you will land inside the X ring.

However our rifles don't hold perfectly still, f-class almost does but your target is only 5”. With sling we are wobbling. So if our 155 palma gun has ammo that is varying 23fps either side of the 3100 average we won't be shooting X ring elevation consistently. Velocities are different and every shot has a different velocity because of a variety of things with the loaded round, but also environmental conditions. That is why when we work up a load often times we use a chronograph to find the load that is the most consistent. Often times SD is used as a way to quantify the precision of a load, it is often misunderstood. If you have a SD of 10 that doesn't mean that all of your shots are going to be 10fps above or 10 fps below your average velocity. To the contrary what that means is only 68.3% will be. The other 31.7% will be higher or lower than that.



If we say our 155 load has a SD of 10 and apply it to the graph we see that the first SD means 68.3% of our shots will be between 3090 and 3110 fps. The next 17.1% of shots or the 2nd SD means 95.4% of our shots will be between 3080 and 3120fps. If you look at our data that means they are still in the X ring. However there is a remaining 4.3% that will be in the 3rd standard deviation, this ends up being approximately 6.5" above and below the center, not an X but we didn't drop any points.

To show the other extreme lets look at the 200-20X, its speed can vary 15fps above or below a 2620fps average and still be able to hit the X ring. Reason it is less is because it has a higher trajectory and a change in fps equates to a larger change in vertical drop. If our SD is 10fps. 68.3% of our shots will still hit in the X ring. So 13-14 shots theoretically are going to be X's. 17.1% of our shots are going to either drop or climb 6.5" so that means 3-4 are going to be 10's and land outside of the X ring but in the 10 ring. That leaves the remaining shots that will drop 9.9" or climb 9.1" which puts them uncomfortably close to being 9s.

So what does this mean? For two bullets with the same SD the slower bullet will have a larger elevation difference on target than the faster bullet because it has less target to work with. This is the reason why people try to get a lower SD because statistically it will help you. But saying we keep the same SD value of 10 used above we can quickly see for the sling shooter where you can get hurt. Say

you have a shot that is in the 3rd SD with your 200s and it is coming out slow. If you break the shot dead on, you have a 10, barely but it is a 10. If you break it high X ring or high 10 you got an X, if you break it low X ring you shot a 9, you break it low in the 10 ring you just shot an 8, and that is BULLSHIT!! Same scenario with 155 shooter he's going to get a shot on the 10/9 line if he breaks a low X or low 10 shot with a round that is 30fps slower than average. This means the heavy bullet shooter theoretically WILL NOT shoot as good of elevation as the 155 shooter. This also means the target has shrunk vertically for the heavy bullet shooter. Just to further show this lets look at the vertical drop distance for the four bullet types when the speed is 10fps below the average.

	Drop (in)
155 Hyb	2.2
168 Hyb	2.6
185 Hyb	3
200x	3.2

As you can see the 200X is dropping 1" more than the 155 Hybrid for a 10fps drop in speed. This is still an X for the sling shooter but for the F-Class shooter this is out of the X ring.

Right now if you are a heavy bullet shooter (such as myself) you are saying well if the target shrinks for the heavy bullet vertically well then it should shrink more for the lighter bullet horizontally because the heavy bullets are better in the wind. Well lets look at that. Middle column is the wind drift in inches at the average speed, followed by the wind drift with a speed of 10fps slower, and the difference. So we will look at this with a 10mph crosswind.

	avg (in)	Avg minus 10fps (in)	Diff (in)
155 Hyb	72.7	73.1	0.4
168 Hyb	72.4	72.8	0.4
185 Hyb	70.6	71	0.4
200x	65	65.4	0.4

As you can see the heavy bullet does get blown less, BUT the difference for all four bullets is exactly the same. So this means the target does not shrink horizontally at all because of the bullet choice. And we would expect this because the whole reason we get vertical shrinkage is because of

gravity. We don't have a horizontal equivalent of gravity (centrifugal force is not a real force) to cause this and that is a good thing.

Now is this just a .30cal issue? No and it actually explains why Any rifles have a higher X count because statistically because of ballistics they can.

	avg (fps)	elevation (MOA)	low	high	Range
90vld	2880	31.51	2861	2900	39
105Hyb	3280	23.51	3251	3311	60
180hyb	2920	27.5	2897	2943	46

If you look at this the 180hybrid at this velocity (280 Remington) has the same speed spread as the 155 shooter. The 243 Winchester shooter with the 105 Hybrid has an even larger spread, meaning with a SD of 10, you would need a round in the 4th SD to shoot outside the X ring. The other interesting thing is the 223 palma shooter with 90VLDs has a speed spread almost as good as the 155s. Also if we do the same horizontal check we see they are virtually the same as the 30cal bullets.

	avg (in)	Avg minus 10fps (in)	Diff (in)
90vld	71.1	71.5	0.4
105Hyb	57	57.3	0.3
180hyb	51.2	51.5	0.3

SO, after reading this we should all shoot 155s in .30cal, or find the fastest shooting gun out there and we will always shoot 200-20X matches at 1000yd because that is what the statistics show. OR we should just quit shooting .308 Win all together and just shoot .223 Remington for Palma. NO, that is not what I am saying especially concerning palma (aside from the fact that Eric Rhode and John Friguglietti would have heart attacks if that happened). We all know that a heavier/better BC bullet does better in the wind and for the Good to Very good shooter the wind is where we lose points. Ironically because of the smaller case size of the 223 vs. 308 it has an inherently greater chance of having velocity error because the same error in powder in a 223 is a bigger percentage of the charge than that same error in a 308.

Also errors are random slow rounds do not always match up to low breaks or fast rounds with

high breaks. You may have low with fast and high with slow and it cancels each other out. Plus we have environmental factors which can affect elevation.

What this article is saying is that if you shoot heavy bullets or shooting a cartridge that maybe doesn't push the bullets to the speeds listed it is imperative that your loads be consistent. The reason being why that bigger slower bullet may help you in the wind, if your loads are crappy you may lose points to vertical. Also this explains why bullets that are heavy for caliber need to be "tuned" because the velocity error shows up as greater elevation error on target. Also it is easy to see why the F-Class shooter does spend more time on his loads because their target is smaller and because F-class shooters smaller , shrinkage hurts them even more. Referring to the F-class target of course, :) LOL.

Now interestingly enough if you take this apply it to shorter ranges you can explain what course shooters say a lot as far as loading their ammo. Course shooters don't weigh their 200/300 yard ammo they just drop it and shoot. Some scoff at this idea thinking how can a loads that vary by .1 or maybe even .5gr still shoot cleans. Well easily, 1. you are closer to the target so the bullet is flatter. 2. Since you are flatter you can have a larger velocity error before you are out of the 10 ring. As you get to 600 you want more consistency in your ammo, but again if you take something like the afore mentioned . 243 Winchester it can get away with ammo that has a higher SD error than say a Palma gun because it is shooting flatter.

So when a palma shooter says 155s hold great elevation, they are correct they do. Statistically they are more capable of holding better elevation than a heavier bullet of the same caliber. If the shooter can read the wind then they are capable of shooting a higher score because they are less likely to lose points to elevation. However wind is challenging to read and some shooters may be better off potentially losing some vertical to make up getting better windage.

In closing any cartridge is capable of shooting a high X clean. It still comes down primarily to shooter position and wind reading. But as shown having a better BC bullet to help you read the wind may cause you some points vertically if your load isn't good enough.