"Ball Weight and Size Difference Effects – Part I" ILLUSTRATED PRINCIPLES

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*Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, technical proofs (TP), and all of my past articles can be accessed and viewed online at **billiards.colostate.edu**. The reference numbers used in the articles help you locate the resources on the website. If you have a slow or inconvenient Internet connection, you might want to view the resources from a CD-ROM or DVD. Details can be found online at: **dr-dave-billiards.com**.*

When playing on some coin-operated bar tables (AKA "bar boxes"), have you ever noticed that sometimes it's difficult to draw the ball, or sometimes the CB rolls forward more than you think it should. Well the reason could be differences in ball weights. The answer could also be that you are looking for excuses for why you missed a shot or position, but let's assume for now that the balls are in fact reacting abnormally. Recently, fellow BD columnist Bob Jewett and I filmed a video showing all of the effects caused by cue ball (CB) and object ball (OB) weight differences. In this article, I'll summarize the effects on square-hit shots, and next month I'll focus on cut shots.

First of all, why would the CB and OB weights be different? In older bar boxes, the CB was made larger and/or heavier to enable the ball-return mechanism to separate the CB from the OBs. Weight differences can also occur with old and worn balls. Generally, with an originally equal-weight set, the CB will tend to be slightly smaller and lighter because it takes more abuse from the cue tip, other balls, and cloth, and it wears faster as a result. The 1-ball can also be smaller and lighter than the other OBs because it takes the full force of the break at the front of the rack. Also, if a new CB is used with an older OB set (e.g., when a CB is replaced due to damage, which seems to occur more and more with phenolic-tip break and jump cues), the CB will generally be slightly larger and heavier than the worn OBs not replaced. The size and weight differences are usually very small, but the effects can sometimes be noticeable, especially on those older bar boxes.

The video Bob and I filmed together can be found in **HSV B.49**. To exaggerate the weight-difference effects, we used different combinations of pool balls and carom balls. Carom balls are noticeably larger and heavier than pool balls. (Pool balls are 2 1/4" in diameter and weight about 6 ounces, and carom balls are about 2 7/16" in diameter and weigh about 7.5 ounces.) As illustrated in **Diagram 1**, with equal-weight balls, a square-hit stun shot, with no top of bottom spin, results in a stop shot, where the CB ideally stops dead in place and delivers all of its speed to the OB. As demonstrated in the video, a stop shot with a heavier CB requires a slight amount of bottom spin. However, "stop shot" is a bit of a misnomer in this case because the CB still drives forward slightly before the drag action of the bottom spin stops the ball. So, strictly speaking, this is not a "stop shot"; although, it is as close to a "stop shot" as you can get with unequal-weight balls. A lighter CB with stun bounces back from the OB, giving the appearance of slight draw (see Diagram 1c). To hit a "stop shot" with a lighter CB, you actually need a slight amount of topspin, which slows the natural backward motion to a stop. With many of the shots in the video, you will notice that the balls bounce some after contact. This is due to the size difference between the balls. Anytime balls hit off of their horizontal equators, they naturally bounce because the impact force between the balls isn't perfectly horizontal.

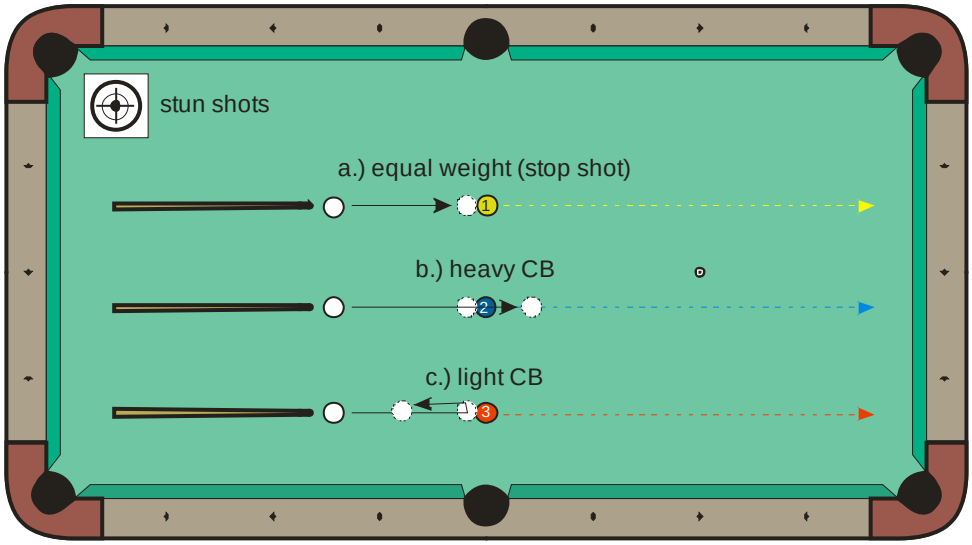

Diagram 1 Stun shot ball weight effects

As illustrated in **Diagram 2**, a heavier CB with topspin follows the OB even more than normal. As demonstrated in **HSV B.49**, the extra weight pushes the CB forward naturally, and the topspin accelerates the ball even more. With a lighter CB, it is more difficult to create follow. As demonstrated in the video, some of the topspin is lost as the natural backward motion is slowed. This leaves less spin to generate forward speed and follow.

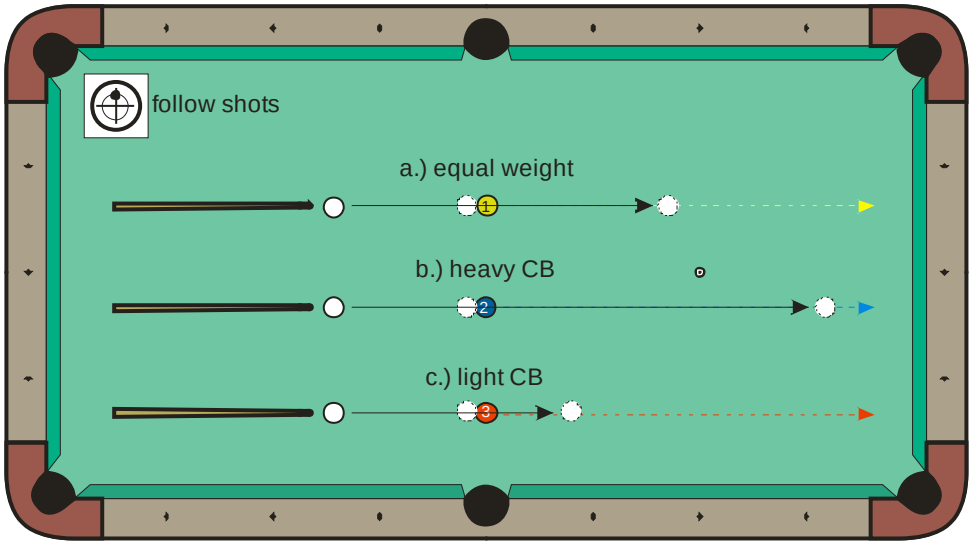

Diagram 2 Follow shot ball weight effects

Diagram 3 illustrates the effects of ball weight on square-hit draw shots. As demonstrated in **HSV B.49**, it takes more effort to draw a heavier CB. Some of the backspin is lost to slow the natural forward motion of the CB after the hit, which leaves less spin to accelerate the CB backwards. A draw shot is very easy with a light CB. The CB bounces back from the OB naturally, and any backspin adds to the draw speed.

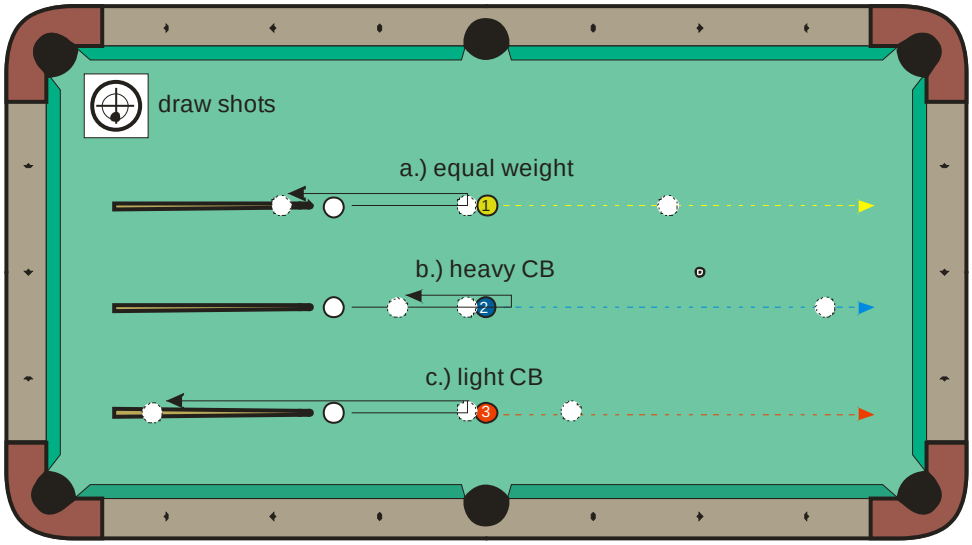

Diagram 3 Draw shot ball weight effects

Diagram 4 shows a game example where a heavier CB can be used to your advantage, in this case to pocket the 8-ball in the side pocket. With a square-hit frozen combination, the 1st ball (the 8) will naturally follow the 2nd ball some naturally (due to interesting physics that occurs with simultaneous collisions of multiple balls), and it will do so more at faster speed. Bottom spin on the CB can be used to assist this action by transferring some topspin to the 1st ball, but this is not required to move the 1st ball forward. With equal-weight balls, there is a practical limit to how far you can send the 1st ball forward with a reasonable-speed shot. However, with a heavier CB, the distance you can send the 1st ball is much greater, making the shot much easier, especially with the OBs are farther from the pocket. Sometimes "inconveniences" like balls of different weights can be quite helpful.

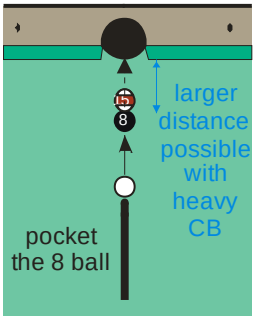

Diagram 4 Moving the 1st ball in a frozen combo

CB size differences, irrespective of the weight differences, also create interesting effects. For example, if you aim normally, as you do with a standard size ball, a larger ball will hit the OB a little thicker than you expect. Conversely, if the CB is smaller than the OB, it will slightly overcut the ball with your normal aim. Also, rail cut shots can be an extra challenge with an over-sized CB. With the CB and OB frozen to the cushion, the line of action of the shot will be slightly into the rail. You can compensate for this by aiming a little up rail with more speed, creating more CB compression into the cushion. You can also aim for simultaneous OB-cushion contact and use outside English to throw the OB back along the cushion. In pool, size (and weight) does matter. Fortunately, over-sized CBs are not as commonplace as they used to be in bar boxes.

Another effect related to weight differences is changes in squirt (AKA CB deflection). A heavier CB will squirt slightly less than normal, and a lighter CB will squirt slightly more. This could require additional aim compensation when using English. Another size effect is racking efficiency. Old and worn OBs will not rack as well as new high-quality balls. Slight mismatches in size and non-spherical shape (due to non-uniform wear) will result in less-tight racks and poor break action (bad spread, more clusters, fewer balls made). Are you convinced yet that it is better to play with balls of equal and standard weights and sizes?

To see how much ball weight can vary in typical conditions, I took an accurate digital scale to my local pool hall ("Match Ups" in Fort Collins, Colorado). I weighed the CB and randomly selected OBs (and the 1-ball specifically) in each of eight Valley bar boxes with the assistance and permission of the owners. (Thanks Mike and Nicole!) The CB weights were fairly consistent with an average of 5.89 oz (167 g), a minimum of 5.78 oz (164 g), and a maximum of 5.93 oz (168 g). The OB weights were lighter (2-3 percent on average) and less consistent with an average of 5.75 oz (163 g), a minimum of 5.47 oz (155 g) and a maximum of 5.89 oz (167 g). The lightest OB was a 1-ball, which makes sense based on the extra abuse it takes (but this could also just be coincidence). If the heaviest CB were paired up with the lightest OB, the percentage difference would be about 8%. Luckily, this is still much less than the 25% difference demonstrated with the pool and carom balls in **HSV B.49**. However, the weight-difference effects in this article would definitely be noticeable with this particular CB-OB combination, especially to a good and observant player.

The next time you play on a bar box with a heavy CB, see if you can notice some of the effects described and illustrated. Next month, we'll look at the effects of ball weight differences on cut shots, and specifically look at the impact on the 90˚ and 30˚ rules. If you don't know the answers yet, think about it based on the info presented this month. There will be a quiz next month (… just kidding).

Good luck with your game,
Dr. Dave


high-speed video

HSV B.49 - Cue ball and object ball weight/size difference effects

PS:

- I know other authors and I tend to use lots of terminology, and I know not all readers are totally familiar with these terms. If you ever come across a word or phrase you don't fully understand, please refer to the online glossary on my website.

Dr. Dave is author of the book, DVD, and CD-ROM: "The Illustrated Principles of Pool and Billiards," and co-author of the DVD Series: "The Video Encyclopedia of Pool Shots (VEPS)" and "The Video Encyclopedia of Pool Practice (VEPP)."