
Note: Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, and technical proofs (TP) can be accessed and viewed online at billiards.colostate.edu. The reference numbers used in the article 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. See the website for details.

This is the fourth of a series of articles concerning “throw” effects. So far, I’ve looked at basic terminology, examples of where throw can help you or hurt you in game situations, the effects of cut angle and speed, and the effects of follow and draw. All of my past articles are available on my website (billiards.colostate.edu) if you want to refer back to them. To refresh your memory, **throw** is change in the object ball direction due to sliding friction forces between the cue ball (CB) and object ball (OB) during impact. **NV 4.15, 4.16, 7.5, and 7.6** show examples of both **cut-induced throw (CIT)** and **spin-induced throw (SIT)**. See the video demos and the previous articles for more information.



- NV 4.15** – Using throw to make a partially blocked shot
- NV 4.16** – Over-cutting a cut shot to compensate for throw
- NV 7.5** – Frozen ball throw
- NV 7.6** – Frozen cue-ball throw

Here is a summary of the most important conclusions from previous articles:

- For small cut angle shots (i.e., fuller hits), the amount of CIT does not vary with shot speed, but increases with cut angle.
- For larger cut angle shots (i.e., thinner hits), the amount of CIT is significantly larger for slower speed shots as compared to faster speed shots.
- The amount of CIT decreases some with larger cut angles.
- Maximum CIT occurs at close to a half-ball hit (30° cut angle).
- CIT is largest for a stun shot.
- Both follow and draw reduce CIT (as compared to stun), and they do so by the same amount.

This month, we will look at spin-induced throw (SIT) resulting from English. As illustrated in **Diagram 1**, English creates a sideways friction force on the object ball that throws the object ball off the impact line (AKA “line of centers”). As shown in **Diagram 2**, left English throws the object ball to the right and right English throws the object ball to the left.

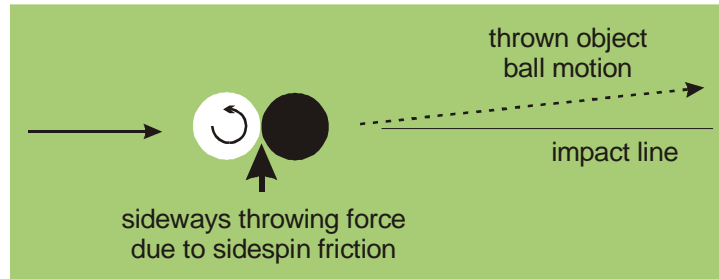


Diagram 1 Spin-induced throw (SIT)

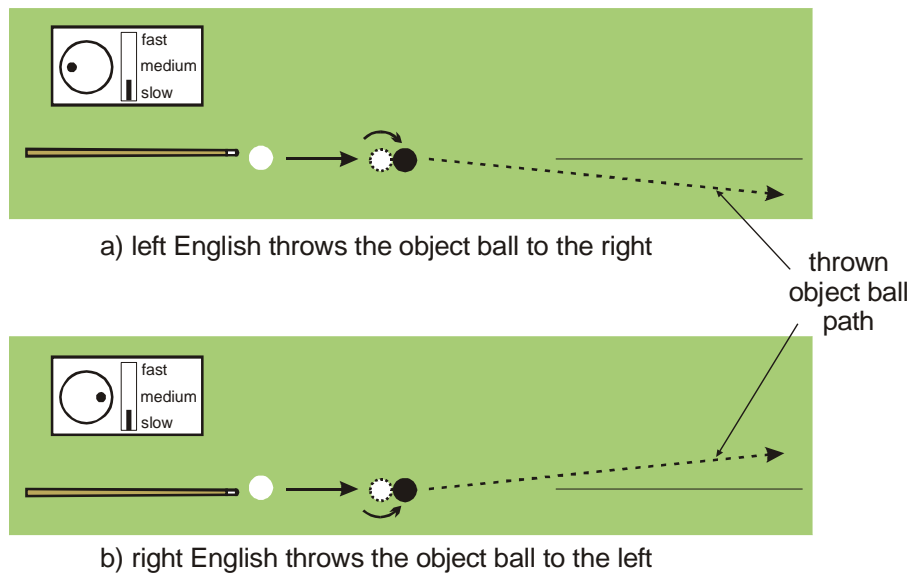


Diagram 2 SIT directions

Diagram 3 shows a graph from the throw analysis in **TP A.14** showing how SIT varies with English and vertical plane spin (i.e., the amount of draw or follow) for a straight-on (zero cut angle) shot as shown in Diagram 1. The graph is a plot of the amount of throw (on the vertical axis) vs. the amount of English (on the horizontal axis). The amount of English is specified as the percentage of maximum recommended English (as described in my July '06 article dealing with "tips of English"). Right English (the right side of the graph) is reported as a positive number and designated with "R," and left English (the left side of the graph) is negative and is designated with "L." Throw to the left (from right English) is labeled negative (the bottom half of the graph), and throw to the right (from left English) is labeled positive (the top half of the graph). The red curve shows how SIT varies with English for a stun shot (0% draw or follow). The green curve shows the effect for a 50% draw or follow shot (i.e., with half the amount of spin as a typical maximum draw or follow shot). The blue curve shows the effect for a maximum spin (100%) draw or follow shot. See my July '06 article for more information about maximum recommended draw/follow/English. As we saw last month, the effects of follow and draw on the amount of throw is the same. The experimental results presented last month proved this for CIT and the detailed math and physics (for the nerds out there) can be found in **TP A.24**. The conclusions also apply to SIT.

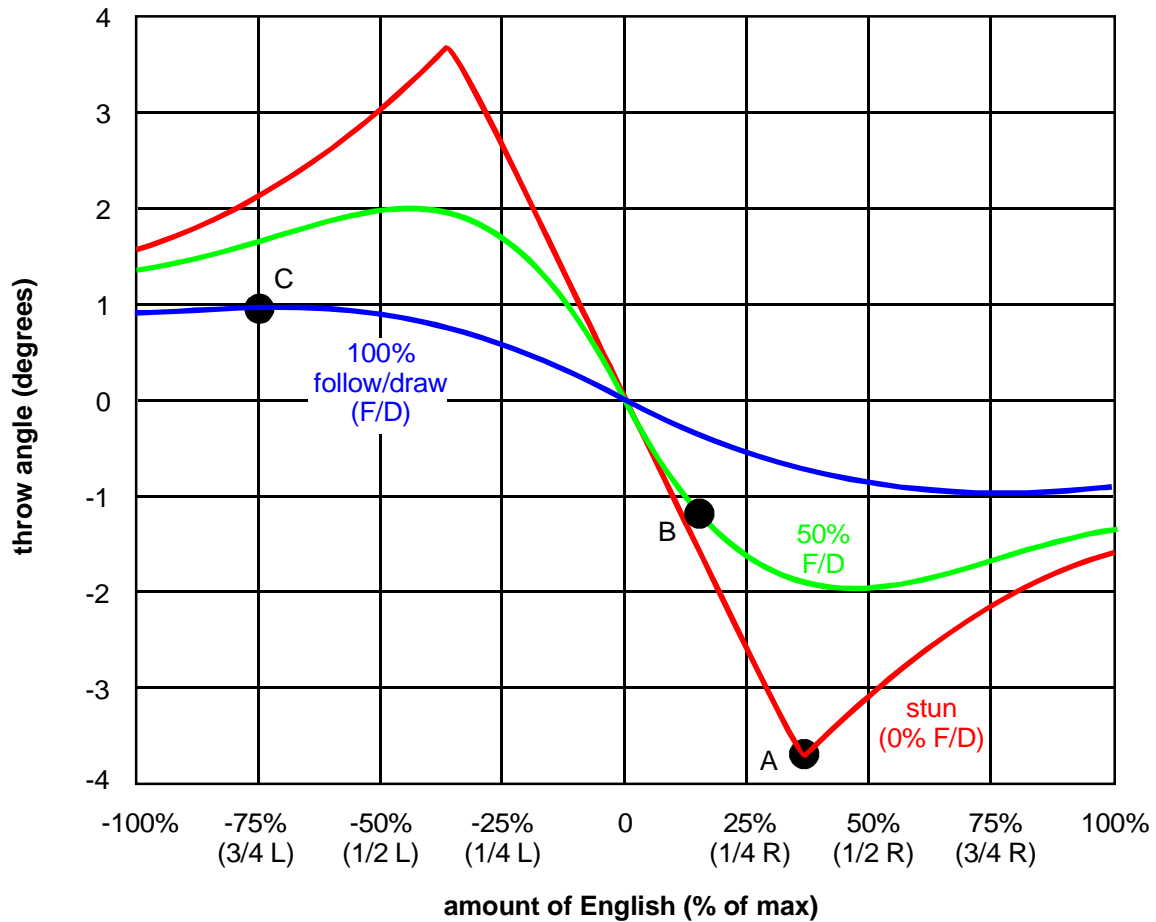


Diagram 3 SIT vs. vertical plane spin and English



TP A.14 – The effects of cut angle, speed, and spin on object ball throw

TP A.24 – The effects of follow and draw on throw

To help interpret the results in Diagram 3, **Diagram 4** illustrates the data for the three example points labeled “A,” “B,” and “C.” Shot “A” is a stun shot with about 35% right English (about 1/2 “tip”), which results in about 3.8° of SIT to the left. Shot “B” is a half spin (50%) follow or draw shot with about 15% of right English (about 1/4 “tip”), which results in about 1.2° SIT to the left. Shot “C” is a maximum spin (100%) follow or draw shot, with about 75% left English (about 1 “tip”), and it results in only about 1° of throw to the right.

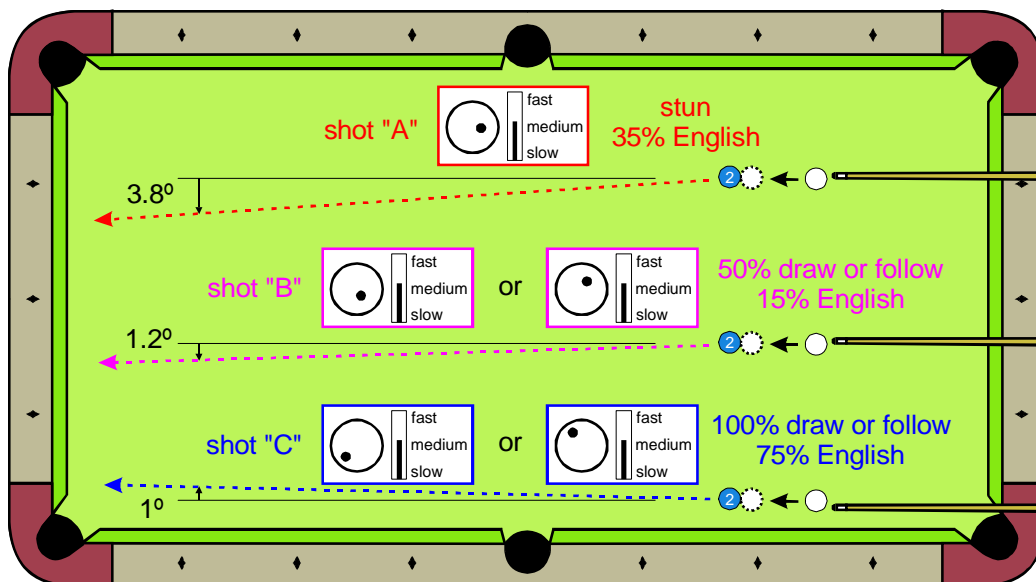


Diagram 4 Example shots from Diagram 3

Here are some conclusions that can be drawn from the graph in Diagram 3:

- SIT is maximum for stun shots.
- Follow and draw both reduce SIT, and they do so by the same amount.
- More English gives you more SIT only up to a point (about 35% English for a stun shot). Additional English (beyond 35% for stun) actually reduces the amount of SIT (i.e., more English doesn't always give you more throw).
- The amount of throw can increase significantly as a small amount of English is added, especially for a stun shot.

So how can this information be useful in your game? Here are a few examples:

1. When not using English, make sure you are hitting the center of that cue ball; otherwise, SIT might make you miss your shot. This is especially important for slow stun shots.
2. If you need to throw an object ball a lot (e.g., as with the shot in NV 4.15), use a soft stun shot with about 35% English (about 1/2 tip). This is one of those cases where more (in this case, English) is not better.
3. If stun is not required for position on the next shot, use draw or follow to minimize the amount of throw. Also, if you are hitting a follow or draw shot with English, remember that you don't need to correct as much for throw (because it is smaller than that for a stun shot).

I hope you are enjoying and learning from my series of articles dealing with throw. Over the next few months we'll look at the combination of CIT and SIT, the effects of outside English, and various approaches for dealing with throw in your game.

Good luck with your game,
Dr. Dave

PS:

- If you want to refer back to any of my previous articles and resources, you can access them online at billiards.colostate.edu.

Dr. Dave is a mechanical engineering professor at Colorado State University in Fort Collins, CO. He is also author of the book: "The Illustrated Principles of Pool and Billiards."