
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 ninth article in my series dealing with “throw” effects. I hope that you’re not thinking: “Enough, already!” I promise that I’m almost done with throw, and soon I’ll move on to other topics. Please bear with me a little longer. 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, the effects of follow and draw, spin-induced throw, the difference between inside and outside English, the combination of spin- and cut-induced throw effects, and spin transfer. If you want to refer back to any of my past articles, they are all available on my website (billiards.colostate.edu). To refresh your memory, **throw** is change in the object ball direction due to sideways 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 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

Last month, I discussed, illustrated, and demonstrated spin transfer and how it is related to throw. You can’t have one without the other. **Spin transfer** refers to spin the CB imparts to the OB during collision (see last month’s article for more info). Recently, there was heated debate on this topic in the Billiards Digest CCB online discussion forum. There are several fairly respected instructors and authors out there who still don’t think spin transfer exists or is significant. In this article, I will show and explain an example that I think will explain the various perspectives accurately.

Diagram 1 illustrates a shot that some people claim proves that throw and spin transfer don’t exist. The CB is hit into the OB with English such that the CB stops, spinning in place. The OB heads straight up table and rebounds off the head cushion straight back with no rebound angle. First of all, this shot, even if it can be executed as shown, doesn’t prove that throw doesn’t exist. If there is any squirt (described below), the cue ball will hit the OB with a slight cut angle; and throw can cancel the squirt effect, resulting in the OB heading straight up-table (see Diagram 2 and the discussion below). Now, if there were no rebound angle off the head cushion, this would seem to indicate that no spin was transferred to the OB. Well, a better way to put it might be: very little spin was transferred to the OB, and what little spin there was mostly wore off as the OB traveled up table. The notes in Diagram 1 explain other reasons why the throw and spin transfer might be very small in this example. If the balls are new, clean, and polished, there will be a lot less throw and spin transfer than normal (see the plots and conclusions at the end of **TP A.27**). Also, if 100% English is used, there will be less throw and spin transfer than if less English were used (see my November ’06 article). Also, if fast speed is used, the throw and spin transfer will be much less than with slower speeds (see my December ’06 article). Also, if follow or draw were used with the English, the amount of throw and spin transfer would be even less (see my October

'06 article). Finally, if the cushion cloth is slick and dry, spin won't "take" as much, so the rebound angle won't be affected as much by what little transferred spin remains.

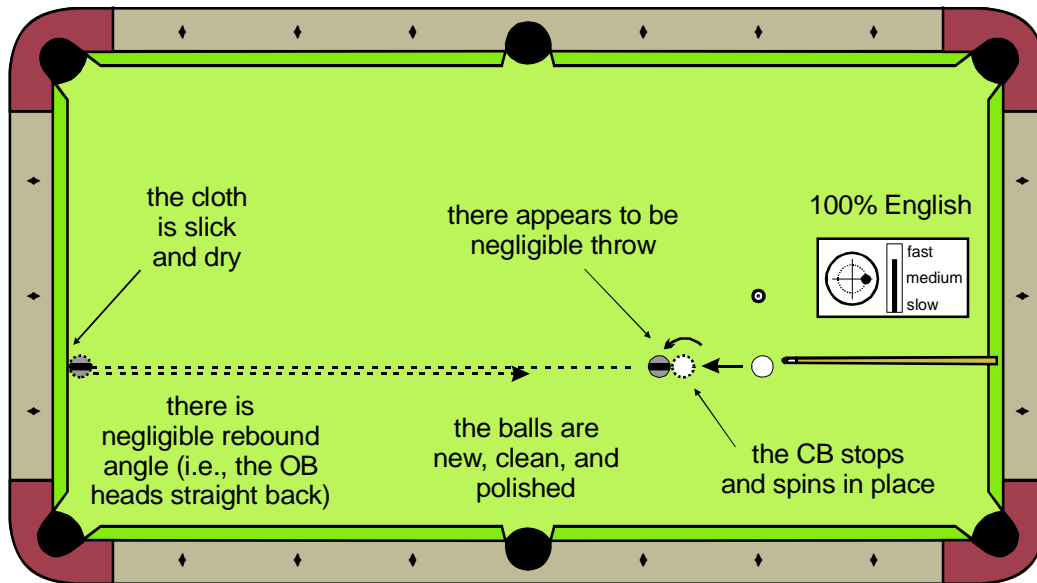


Diagram 1 Example shot where throw and spin transfer are not noticeable



TP A.27 – Spin transfer

Diagram 2 shows the same shot as in Diagram 1, but this time with less speed and spin, and now assuming more-typical playing conditions. By typical playing conditions, I mostly mean that the balls are not brand new, perfectly clean, and polished smooth (i.e., what you would find in typical home game rooms, pool halls, and bars). As shown in the diagram, the CB squirts to the left a little because of the right English (see **NV 4.13** and **NV A.17**). Even with a low-squirt (AKA low CB deflection) cue, squirt is still a factor. Therefore, the cue ball hits the OB with a slight cut angle to the right. But the right English throws the OB to the left; so the throw can cancel the squirt effect, and the OB can still head straight up-table. Because of the cut angle, you might think the CB should drift left a little after impact. However, because the CB is throwing the OB to the left, the OB exerts an equal and opposite force back on the CB (to the right). This cancels out the cut angle effect, so the CB stops in place spinning. I demonstrate and describe how this works with the series of shots in **NV A.21**. As we saw last month, if there is throw, there must be spin transfer. And sidespin is very persistent, meaning it doesn't wear off very much as the OB heads up-table. The spin causes the OB to bounce off the head cushion with a rebound angle. To get maximum throw and spin transfer on this shot, you want to use a slower speed and about 50% English (see my December '06 article). Slight draw is shown in the diagram to achieve stun at OB impact to also help create maximum effect (see my November '06 article).

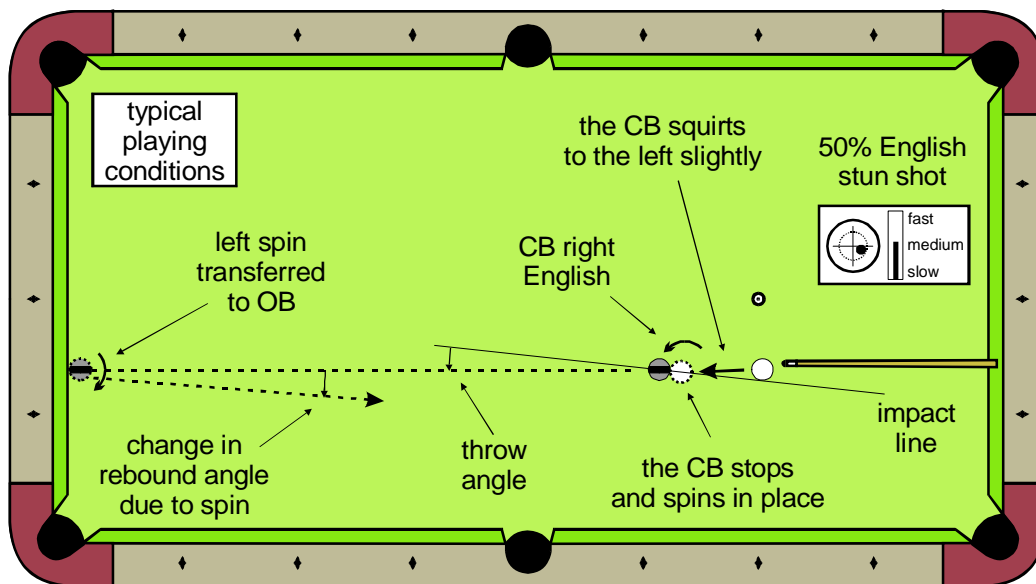


Diagram 2 Same example with throw and spin transfer evident



normal video

NV 4.13 – Squirt due to high speed English

NV A.17 - English deflection (squirt) vs. speed

NV A.21 – Bank shot using throw and spin transfer

If you want to try out this shot yourself (which I highly recommend for all shots in all articles and books you read), be sure to use a striped ball for the OB to help you see the spin transfer effect. If you line up the stripe in the direction of the shot, and you hit the OB straight up-table, and there is no spin transfer, the stripe should stay aligned straight as the ball rolls. If, on the other hand, the stripe wobbles, then that is evidence that sidespin has transferred to the OB. If you are still skeptical of the significance of throw and spin transfer, please look back at NV A.21. I think the bank example demonstrated and explained in that clip provides pretty convincing evidence of the effects. If that's not proof enough, **HSV A.66** provides a visual high-speed video demonstration; and for the physics nerds out there, TP A.27 provides a physics-based mathematical proof.



high-speed video

HSV A.66 – Straight-on shot with English and slow speed

I think the explanations and examples in this article help settle some of the debate that has appeared on the online forum lately. If it doesn't, I give up ... I gave it my best try. I hope you are enjoying and learning from my series of articles dealing with throw. Next month, I'll look at examples of outside and inside English and how an understanding of throw effects can help you at the table.

Good luck with your game,
Dr. Dave

PS: I want to thank user "Jal" on the Billiards Digest CCB online forum. He helped my spot and fix several errors in my original spin transfer analysis (TP A.27). Jal, please continue to help keep me honest. I also want to thank "cushioncrawler" for helping to spur some interesting discussion and debate.

PS: I know other authors and I tend to use a lot of terminology (e.g., squirt, throw, stun, impact line, etc.), and I know not all readers are totally familiar with these terms. If you ever come across a word you don't fully understand, please refer to the glossary in my book. For convenience, I have a copy of it posted online in the "Instructor and Student Resources" section of my website.

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