Whose Bullet?

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Here is a probability problem from BL's Weekly Math Games.[1] Normally I am not a fan of such problems, but this one seemed fairly straight-forward for a change.

> I hit the target 75% of the time. You hit the target 25% of the time. We aim at the same time, and only one bullet hits. What's the probability it came from me?
>
> Now as for this puzzle, it would be tempting to think that I am 3 times as good at hitting the target, but I am not!

Solution

Table 1 shows the possible outcomes of one turn of our target practice. Either we both miss, both hit, or only one of us hits the target. The case of one of us hitting the target is shown in green.

Table 1

Me You	Hit Prob = 3/4	Miss Prob = 1/4
Hit (Prob = 1/4)	3/16	1/16
Miss (Prob = 3/4)	9/16	3/16

This turns out to be a conditional probability problem. That is, we are not being asked what is the probability that I hit the target, but rather *if only one of us hits the target*, what's the probability it was me? So we are restricting ourselves to the green case. In that case, there is a 90% chance the single bullet in the target came from me, whereas there is only a 10% chance it came from you. So the answer is 90%.

Why the chance of having the bullet be yours is reduced from 25% to 10% is that most of the time when your bullet hits the target, mine also hits the target.

Futility Closet-Winkler Solution

Again, I am not a subscriber, so I don't know what the BL solution is, but I just came across a Futility Closet problem[2] that was essentially the same and it came from Peter Winkler's *Mathematical Puzzles* (2021). Instead of "me" and "you", he has shooters A and B.

> At first it might seem that the answer is 75 percent, since A is three times as good a shot as B. "But there are two things happening here: hitting and missing," writes Dartmouth mathematician Peter Winkler. The probability that A hits and B misses is 3/4 × 3/4 = 9/16, and the probability that B hits and A misses is 1/4 × 1/4 = 1/16. So there's fully a 9/10 chance that the successful bullet was A's.

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[1] 17 November 2024 (https://medium.com/math-games/i-am-not-3-times-as-good-as-you-aba395947abb)
[2] 15 January 2025 (https://www.futilitycloset.com/2025/01/15/gun-control-2/)