In or Out? The New Flagstick Dilemma for Putting in Golf

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1 Introduction

Fans of the Professional Golfers Association Tour have witnessed a strange sight since 2019–golfers putting with the flagstick (a.k.a., pin) *in the hole*. Prior to 2019, players were assessed a two-shot penalty if a ball putted on the green came into contact with a flagstick. To simplify and speed up play, the governing bodies for the rules of golf, the United States Golf Association (USGA) and the R&A, changed the rule regarding ball contact (Rule 13.2a). The USGA stated that "it is expected that there is no advantage in being able to putt with the unattended flagstick in the hole."

The majority of touring professional golfers have decided to take the flagstick out since the rule change, citing reasons such as tradition and fear the flagstick might reduce their probability of making a putt. For example, Justin Thomas said at tournament that

> If I have an eight-footer to win a golf tournament, I can't, I mean no offense, I can't really take myself seriously if I kept the pin in. I mean it just would be such a weird picture and like on TV me celebrating and like the pin is in and

> my ball's like up against it ... If I have a putt I'm trying to make, that thing's coming out.

A few others advocated for leaving the flagstick in the hole because they believed it would increase their probability of making a putt. In particular, Bryson DeChambeau said at a tournament that

> Pin in, is an easy one. It's statistically proven to be a benefit in 99 percent of situations ... Anything outside 10 feet I'm going to leave it [flagstick] in. If I accidentally hit it [ball] three feet instead of two feet past the flag, it [ball] will stay in the cup. It [ball] has a better potential of staying in the cup than with it [flagstick] out.

With no consensus among golfers, a few golfing groups have performed experiments using simplistic data analyses to determine the better strategy. Interestingly, there was no consensus among these groups as well! The goal of our article is to develop a strategy for putting success. For this purpose, we examine in detail what we believe was the best experiment performed by the golfing groups and use proper statistical modeling and inference methods to analyze the data. We also reconcile the different conclusions reached among the groups.

2 Background

The potential benefit from leaving a flagstick in the hole is similar to that for a bank shot in the sport of basketball. Basketball players will often shoot a ball so that it bounces off the backboard and fall into the basket. The flagstick in golf can serve a comparable role as a backboard. Specifically, a flagstick can cause a ball to drop into the hole that might have otherwise skipped over it because the ball was moving at a high speed. An important difference between a backboard and a flagstick is that the backboard is completely behind the basket, whereas the flagstick is within the hole. Approximately 1.875 inches are between the flagstick and the outer edge of the hole, leaving a very small space for a golf ball (1.68

inches in diameter) to fit within. Another important difference is that a flagstick is cylindrical rather than a flat surface. Hitting the center of the flagstick allows one to mimic a straight-on bank shot, but there is little margin for error. In the end, a flagstick may actually impede a ball from dropping into the hole by deflecting it away, leading to a putt missed that may have been made otherwise.

The Edoardo Molinari Golf Academy (EMGA) performed a three-factor experiment in an attempt to solve the flagstick in/out dilemma. The main factor of interest, flagstick, simply had levels of in and out of the hole. The other two factors focused on the backboard-like effect that the flagstick can have on a golf ball. A ball-speed factor represented the speed of the ball once it reached the hole. Relative to *if* there was no flagstick in the hole, the levels of this factor were 1) low: the ball would land in the bottom of the hole, 2) medium: the ball would hit the back of the hole below the rim, and 3) high: the ball would bounce up into the air upon reaching the hole. An entry-line factor represented where the ball is located once it reached the hole. Relative to *if* a flagstick was in the hole, the levels of this factor were 1) center: the ball would hit the middle of the flagstick, 2) slightly off-center: the ball would hit the flagstick left/right of center, and 3) grazing: the ball would barely touch the flagstick left/right of center.

To control ball speed and entry line, a Perfect Putter, a proprietary ramp system from which a ball can be rolled down (`www.theperfectputter.com`), was used by EMGA to set the ball into motion toward the hole. Starting the ball in motion from different heights controlled the speed factor. Positioning the ramp controlled the entry-line factor. While an actual putt does not take place with the Perfect Putter, we will still refer to these as putts due to the purpose of the experiment. EMGA provided a helpful video at `www.instagram.com/p/Bsdkf1blJPd` demonstrating these experimental factors and its procedure. The experiment was repeated 100 times for each factor-level combination. Table 1 provides the observed proportions of success. For example, 38 out of 100 (38%) were successful with the flagstick out for medium-speed putts that would have grazed the flagstick, whereas only 14 out of 100

Table 1: Observed proportion of successful putts for "flagstick out, flagstick in" from the experiment performed by EMGA.

		Ball speed at the hole		
		Low	Medium	High
Entry line at the hole	Center	100%, 100%	100%, 100%	81%, 100%
	Slightly off-center	100%, 100%	73%, 45%	0%, 7%
	Grazing	100%, 100%	38%, 14%	0%, 0%

(14%) were successful with the flagstick in.

3 Analyses

We present two separate statistical analyses to determine which flagstick strategy is better. We use two analyses because the data contain many 0% and 100% observed success proportions for factor-level combinations. These extreme values can cause problems for statistical procedures. To deal with these potential problems, we use procedures that are known to perform well and/or implement procedures with commonly used modifications to help them perform well.

3.1 Analysis #1

Table 2 displays score confidence intervals for the difference of two probabilities. These intervals are constructed so that the probability of success for the flagstick in, say π_{in}, is always subtracted from the probability of success for the flagstick out, say π_{out}. Thus, the intervals are for $\pi_{out} - \pi_{in}$ at every combination of the ball speed and entry line levels.

Due to the frequent 0% and 100% observed success proportions, many of these intervals are $-0.07 < \pi_{out} - \pi_{in} < 0.07$. Because 0 is within these intervals, there is not sufficient evidence to indicate a difference between the flagstick strategies for the corresponding factor-level combinations. This includes all of the factor-level combinations for putts reaching the hole at a low speed. On the other hand, intervals are above 0 for off-center putts reaching

Table 2: Score confidence intervals for the difference in the probability of success ($\pi_{out} - \pi_{in}$). Bonferroni adjustments are used to obtain a 95% familywise confidence level. Table cells are highlighted in blue (red) when there is at least marginal evidence that the flagstick out (in) is the preferred strategy.

		Ball speed at the hole		
		Low	Medium	High
Entry line at the hole	Center	$(-0.07, 0.07)$	$(-0.07, 0.07)$	$(-0.32, -0.10)$
	Slightly off-center	$(-0.07, 0.07)$	$(0.09, 0.45)$	$(-0.18, 0.00)$
	Grazing	$(-0.07, 0.07)$	$(0.07, 0.40)$	$(-0.07, 0.07)$

the hole at a medium speed. Thus, taking the flagstick out is the better strategy. For putts reaching the hole at a high speed, the reverse conclusion is reached at times. For center entry line and high-speed putts, there is strong evidence that leaving the flagstick in increases the probability of success, where the flagstick essentially plays the role of the backboard for a bank shot in basketball. The evidence is not as strong for slightly off-center putts reaching the hole at a high speed. While the interval is shifted toward the negative side, 0 is still within it. Thus, there is only marginal evidence that leaving the flagstick in is helpful for that particular case.

3.2 Analysis #2

Our second approach uses a logistic regression model to estimate the probability of success by taking into account the three factors. Unfortunately, this modeling approach cannot be applied directly to the data due to the 0% and 100% observed success proportions. For this reason, we incorporate a commonly used adjustment to the data by adding/subtracting 0.5 to counts corresponding to the 0%/100% cells in Table 1, respectively. For example, putts arriving at a low speed and on center at the hole would have a 99.5% observed success rate rather than a 100% success rate. We include ball speed and entry line in the model as qualitative factors using indicator variables. We also attempted to include these factors as single terms through the use of scores (e.g., speed could have values of 1, 2, and 3), but models with qualitative factors provided a better fit.

Table 3: Maximum likelihood estimates and profile likelihood ratio confidence intervals for odds ratios comparing flagstick out vs. flagstick in. Bonferroni adjustments are used to obtain a 95% familywise confidence level. Table cells are highlighted in blue (red) when there is at least marginal evidence that the flagstick out (in) is the preferred strategy.

	Ball speed at the hole		
	Low	Medium	High
Estimate	1.00	3.45	0.10
Confidence interval	$(0.04, 25.2)$	$(2.02, 6.02)$	$(0.02, 0.33)$

Through using Akaike's Information Criteria (AIC), we found the best model to include the main effects of flagstick, entry line, and ball speed and the interaction for flagstick and ball speed. Therefore, how ball speed affects the probability of success is dependent on whether the flagstick is in or out. This interaction is examined further by the odds ratios displayed with profile likelihood ratio intervals in Table 3. These odds ratios are constructed so that the odds of a successful putt when the flagstick is out is divided by the odds of a successful putt when the flagstick is in. For putts reaching the hole at a medium speed, the estimated odds of a successful putt are 3.45 times as large when the flagstick is out than when the flagstick is in, holding the entry line constant. Because the corresponding interval is above 1, this indicates that there is sufficient evidence that taking the flagstick out is the better strategy for success. On the other hand, for putts reaching the hole at a high speed, the corresponding interval is below 1, indicating that leaving the flagstick in is the better strategy for success, holding the entry line constant.

Similar to Section 3.1, we also construct confidence intervals for $\pi_{out} - \pi_{in}$, but now using our model. Table 4 shows these Wald-based intervals that use delta-method approximations for standard errors. Overall, we have similar interpretations as in Section 3.1. In particular, there is only marginal evidence that leaving the flagstick in is helpful for putts reaching the hole off-center and at a high speed.

Table 4: Wald confidence intervals for the difference in the probability of success ($\pi_{out} - \pi_{in}$) resulting from the fit of the logistic regression model. Bonferroni adjustments are used to obtain a 95% familywise confidence level. Table cells are highlighted in blue (red) when there is at least marginal evidence that the flagstick out (in) is the preferred strategy.

		Ball speed at the hole		
		Low	Medium	High
Entry line at the hole	Center	$(0.00, 0.00)$*	$(-0.00, 0.00)$*	$(-0.28, -0.06)$
	Slightly off-center	$(-0.01, 0.01)$*	$(0.15, 0.43)$	$(-0.13, -0.01)$
	Grazing	$(-0.04, 0.04)$*	$(0.11, 0.34)$	$(-0.03, 0.00)$*

*Due to the success rates for these factor-level combinations and the delta-method approximations, the quality of these intervals is questionable.

4 Conclusion

In or out? Our conclusion depends on ball speed and entry line. For low-speed putts, there is not sufficient evidence that flagstick placement matters. For putts reaching the hole at a medium speed, putting with the flagstick out is the better strategy for off-center putts (not enough evidence either way for on-center putts). For putts reaching the hole at a high speed, leaving the flagstick in is better for putts that would hit the center of the flagstick, suggesting a similar effect as observed for bank shots in basketball. For high-speed, off-center putts, the evidence is not as strong that leaving the flagstick in is the better strategy. Overall, our conclusions mostly match the simplistic data analysis given by EMGA that only interpreted the observed proportions of success. One of the benefits from our analysis is that it shows that most of their interpretations were not necessarily due to experimental variability. For the reproducibility of our research, we include the R code used for our analysis at `www.chrisbilder.com/research/Chance`.

Because speed and entry line are not as easily controlled by a golfer as they are by a Perfect Putter, this makes the flagstick in/out decision more complicated for golfers. When faced with this decision on a green, we recommend that golfers take the flagstick out. Golfers are more likely to have a ball reach the hole at a medium speed than at a high speed. Relative to our statistical modeling and inference methods, taking the flagstick out would benefit golfers more than it would hurt them.

The flagstick in/out dilemma has led to experiments performed by other golfing groups as well. Unfortunately, none of these groups use statistical modeling and inference methods to justify their conclusions. Rather, similar to EMGA, these conclusions appear to rely only on the observed proportions of success at particular factor-level combinations. Support for taking the flagstick out includes the research performed by mechanical engineering professor and *Golf Digest* contributor Tom Mase. This research also looked at other factors for this problem, including whether leaving the flagstick in could be used as a sight tool for putting. Through testing with athletes from college golf teams, the evidence was not conclusive that one flagstick strategy was better than the other. Support for leaving the flagstick in includes research by short-game expert Dave Pelz, which was based on experiments performed long before the rule change. The MyGolfSpy group also advocated for leaving the flagstick in and provided data to support their conclusions. Our sidebar provides a description of the experiment and our own analysis of their data. While trends exist among the observed proportions that suggest leaving the flagstick in is the better strategy, there is only strong evidence for this conclusion relative to their version of high-speed putts.

Why are there conflicting conclusions among the golfing groups? While the absence of statistical inference methods for data analyses is likely one reason, we believe that how ball speed is included in the experiments is the main reason. EMGA equate ball speed at the hole to a measurement of the force that the ball exerts on the flagstick upon impact, while others equate ball speed to how far the ball would roll *past the hole* if the hole did not exist. This latter measure is used because a golfer will typically attempt to strike a putt at a level such that the ball will go no further than three feet past the hole if the putt is missed. However, distance past the hole is dependent on a number of factors, such as green speed, wind speed, and green slope, so that measurement of speed does not adequately address the amount of force a ball applies to the flagstick upon contact. In addition, many of these experiments focusing on past-the-hole measurements use unrealistic distances. For example, the MyGolfSpy group used 6 and 9 feet as distances past the hole, which does not happen

often for most golfers (at least for touring professionals) in situations similar to the group's experimental setting. We believe that these past-the-hole types of experiments and their resulting conclusions are observing what EMGA observed for its high-speed putts.

Further Reading

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Sidebar

Four factors investigated by the MyGolfSpy experiment were:

1. Flagstick: In or out
2. Ball speed: Measured as the distance that the ball would travel past the hole if the hole was not present; levels of 3, 6, and 9 feet

Table 5: Observed proportion of successful putts for "flagstick out, flagstick in" from the experiment performed by the MyGolfSpy group.

Standard rigidity		Distance past the hole (ball speed)		
		3'	6'	9'
Entry line at the hole	Center	100%, 100%	35%, 100%	5%, 80%
	Off-center	40%, 85%	10%, 40%	0%, 0%

High rigidity		Distance past the hole (ball speed)		
		3'	6'	9'
Entry line at the hole	Center	100%, 100%	35%, 100%	5%, 70%
	Off-center	40%, 60%	10%, 15%	0%, 0%

3. Entry line of ball: Center or off-center strike of the flagstick relative to if a flagstick was in the hole

4. Rigidity of flagstick: Standard or high

The experiment was repeated 20 times for each factor-level combination. The observed proportions of success for each factor-level combination are given in Table 5. Score confidence intervals for $\pi_{out} - \pi_{in}$ are given in Table 6. These intervals show that there is strong evidence that leaving the flagstick in the hole is the better strategy for the 6 and 9-feet past-the-hole putts with a center entry line. Marginal evidence exists to leave the flagstick in the hole for the 3-feet past-the-hole, off-center putts attempted with a standard rigidity flagstick. For other factor-level combinations, the evidence is not sufficient that one strategy is better than the other.

Table 6: Score confidence intervals for the difference in the probability of success ($\pi_{out} - \pi_{in}$). Bonferroni adjustments are used to obtain a 95% familywise confidence level. These intervals correspond to the data given in Table 5. Table cells are highlighted in red when there is at least marginal evidence that the flagstick in is the preferred strategy.

Standard rigidity		Distance past the hole (ball speed)		
		3'	6'	9'
Entry line at the hole	Center	$(-0.30, 0.30)$	$(-0.87, -0.28)$	$(-0.92, -0.33)$
	Off-center	$(-0.75, -0.01)$	$(-0.63, 0.11)$	$(-0.30, 0.30)$

High rigidity		Distance past the hole (ball speed)		
		3'	6'	9'
Entry line at the hole	Center	$(-0.30, 0.30)$	$(-0.87, -0.28)$	$(-0.87, -0.23)$
	Off-center	$(-0.58, 0.24)$	$(-0.40, 0.31)$	$(-0.30, 0.30)$