# An Investigation into Why Horse Racing Experts Chose Not to Enter Their Horses in Other Similar-Distance Races

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***Abstract*—In this study, we focus on horse racing experts, such as racing horse owners and trainers, and investigate why they chose not to enter their horses in other similar-distance races. Using sire line, distance of races, and order of finish as clues, we analyze the 36922 horses registered with Japan Racing Association from 2010 to 2017 statistically. The results of the statistical analysis showed that many horse racing experts chose not to enter their horses in other races of any distance when their horses did not perform well in the first races or the two or three consecutive races of that distance. This result also suggested that many horse racing experts did not consider sire lines when choosing not to enter their horses in other similar-distance races as they do when selecting race distance.**

***Keywords-decision making; expert; Thoroughbred horse; sire line; race distance.***

## I. INTRODUCTION

It is often said that finishing something is harder than starting it. Take horse racing experts, such as racing horse owners and trainers, for example. The first thing they have to do with their horses is to choose which races to enter them in. On the other hand, the last thing they have to do with their horses is to choose not to enter them in any more races. If the above saying is correct, it is harder for horse racing experts to choose not to enter their horses in any more races than it is to choose which races to enter them in. In this study, we focus on horse racing experts and investigate why they chose not to enter their horses in other similar-distance races.

In order to investigate why horse racing experts chose not to enter their horses in other similar-distance races, we focus on sire line, distance of races, and order of finish. A sire line is a term that refers to the paternal lineage or ancestry of a horse, especially a racehorse. Many horse racing experts often say that a sire line can indicate the potential abilities or characteristics of a horse, such as which distance races they are good at [1] [2]. In this study, we analyze horses classified into one sire line type statistically and report why horse racing experts chose not to enter them in other similar-distance races.

The rest of this paper is organized as follows: In Section II, we survey the related works. In Section III, we survey information about racehorses and show how to collect it. In Section IV, we show how to analyze racehorse information statistically and discuss why horse racing experts chose not to enter their horses in other similar-distance races. Finally, in Section V, we present our conclusions.

## II. RELATED WORK

Thoroughbred horses originated from a small number of Arab, Barb, and Turk stallions and native British mares approximately 300 years ago [3]–[5]. Since then, they have been selectively bred to improve speed and stamina, and are consequently superior competitive racehorses. Wade et al. reported a high-quality draft sequence of the genome of the horse and suggested that the horse was domesticated from a relatively large number of females, but few males [6]. McGivney et al. reported that centuries of selection for favourable athletic traits among Thoroughbreds acts on genes with functions in behavior, musculoskeletal conformation, and metabolism [7]. Recently, some genomic regions were identified as a candidate region influencing racing performance in racehorses [8]. Many researchers applied statistical models to evaluate various parameters on racing performance in Thoroughbred horses [9]. Martin, Strand and Kearney reported that the most influential parameter was distance raced [10]. Cheetham et al. investigated whether both race earnings and number of race starts were associated with horse signalment (age, sex, and breed), gait, and race surface [11]. Wells, Randle and Williams investigated how temporal, behavior, and loading related factors associated with the period before the start of the race influences racehorse performance [12].

Statistical researches are conducted not only in horse racing but also in other sports, such as baseball. In recent years, statistical researches brought a new batting approach that batters should aim for big fly balls rather than grounders [13]. Kato and Yanai reported that Shohei Otani, the Japanese superstar slugger in Major League Baseball (MLB), always aims for hitting fly balls [14]. This new batting approach, the so-called "fly-ball revolution", shows that even experts may make mistakes. As a result, it is important to discuss how experts made decisions and why they made mistakes. Yerkes and Dodson studied the relationship between arousal and performance and showed that a little stress can help we perform a task, however, too much stress degrades our performance [15]. Weinschenk used Alex Rodriguez as an example to show that even experts can make mistakes when the stakes are high [16]. Aircraft pilots are under a great deal of mental stress when they are flying their planes. Shappell and Wiegmann focused on preventing errors in aviation, including decision errors, and propose a framework for analyzing and

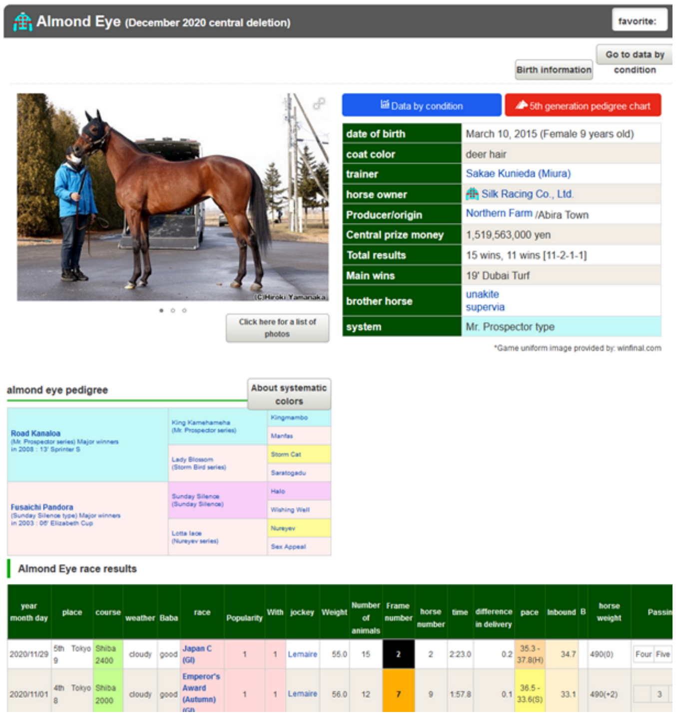



Figure 1. An example of horse information provided by Keiba Lab.

TABLE I
THE NUMBER OF HORSES REGISTERED WITH JRA FROM 2010 TO 2017.

| year | number of registered horses |
|---|---|
| 2010 | 4470 |
| 2011 | 4524 |
| 2012 | 4505 |
| 2013 | 4595 |
| 2014 | 4672 |
| 2015 | 4663 |
| 2016 | 4738 |
| 2017 | 4755 |
| Total | 36922 |

TABLE II
THE NUMBER OF HORSES CLASSIFIED INTO THE THREE MAIN SIRE LINE TYPES.

| sire line | number of horses |
|---|---|
| Native Dancer Line | 8799 |
| Nearctic Line | 6383 |
| Royal Charger Line | 18104 |
| others | 3636 |
| Total | 36922 |

classifying human errors [17]. Kang and Yoon studied the types of errors that both younger and older adults make when learning how to use new technologies [18]. They found that older adults used different strategies than younger adults. However, they did not report how experts made mistakes.

## III. A COLLECTION OF RACEHORSE INFORMATION

Keiba Lab [19] is one of the most popular horse racing information sites in Japan. This site records various information about all racehorses registered with Japan Racing Association (JRA) and registered users can freely access it. Figure 1 shows an example of horse information provided by Keiba Lab. As shown in Figure 1, the horse information provided by Keiba Lab consists of personal information and race results. Personal data consists of name, date of birth, age, sex, coat color, breeder, birth place, owner, trainer, ancestors up to three generations ago, sire line, career statistics, career prize money, and so on. Race results consist of venue, event date, distance, weather, racetrack, surface, race name, favourite, order of finish, jockey, weight, horse number, frame number, time, and so on. In order to discuss why horse racing experts chose not to enter their horses in other similar-distance races, we collected information about 36922 horses registered with JRA from 2010 to 2017 from Keiba Lab. Table I shows the number of horses registered with JRA from 2010 to 2017.

On Keiba Lab, various sire lines are used to classify horses. We surveyed how racehorse sire lines diverged and grouped them into Native Dancer Line, Nearctic Line, Royal Charger Line, and others. For example, Figure 1 shows that the sire line of *Almond Eye* was Mr. Prospector Line. It branched out from Native Dancer Line. As a result, in this study, we determined that the sire line of *Almond Eye* was Native Dancer Line. Then, we classified 36922 horses registered with JRA from 2010 to 2017 into these four types. Table II shows the number of horses classified into these four sire line types. As shown in Table II, 90 percent of the 36922 horses were classified into the three main sire lines: Native Dancer Line, Nearctic Line, and Royal Charger Line.

36922 horses had competed in races of various distances. We grouped the race distances into five types: 1000 – 1399m, 1400 – 1799m, 1800 – 2199m, 2200 – 2799m, and more than 2800m. Then, we investigated which distance races and how many times the 36922 horses had competed in. For example, *Almond Eye* had competed in one 1000–1399m race, six 1400–1799m races, four 1800–2199m races, and four 2200 – 2799m races. Table III shows the distance and number of races the 36922 horses had competed in. Table IV shows the number of times the 36922 horses of four sire lines had competed in races of various distances. Table V shows the number of horses of four sire lines had competed in races of various distances. The point to note is that horse owners get prize money when their horses place in the top five in races held by JRA.

## IV. ANALYSIS OF DECISION MAKING OF HORSE RACING EXPERTS

In this section, we investigate why horse racing experts chose not to enter their horses in other similar-distance races. Furthermore, we associate the result of the investigation with experts' race selection.

### A. Basic idea

It is widely recognized that inherited variation in physical and physiological characteristics is responsible for variation in individual aptitude for race distance. Many horse racing



TABLE III
THE DISTANCE AND NUMBER OF RACES THE 36922 HORSES HAD COMPETED IN.

| | race distance | | | | | |
|---|---|---|---|---|---|---|
| | 1000-1399m | 1400-1799m | 1800-2199m | 2200-2799m | 2800m- | Total |
| number of races | 5144 | 7433 | 7247 | 2083 | 1244 | 23151 |

TABLE IV
THE NUMBER OF TIMES THE 36922 HORSES OF FOUR SIRE LINES HAD COMPETED IN RACES OF VARIOUS DISTANCES.

| | race distance | | | | | |
|---|---|---|---|---|---|---|
| sire line | 1000-1399m | 1400-1799m | 1800-2199m | 2200-2799m | 2800m- | Total |
| Native Dancer | 27008 | 31619 | 28568 | 4173 | 2511 | 93879 |
| Nearctic | 18710 | 22444 | 20072 | 2838 | 1647 | 65711 |
| Royal Charger | 42525 | 67514 | 71758 | 13181 | 5848 | 200826 |
| others | 9879 | 12058 | 10780 | 1817 | 876 | 35410 |
| Total | 98122 | 133635 | 131178 | 22009 | 10882 | 395826 |

experts would agree that if the best race distance of ancestors is known, the offspring's best race distance is most likely to take after them. As a result, we focus on three factors of racehorses: sire line, race distance, and order of finish. In this section, we first investigate whether horse racing experts entered their horses of certain sire lines in races of certain distances too many times or too few times. The result of this investigation shows which distance races the experts thought were favorable or unfavorable for racehorses of a certain sire line. Next, we investigate whether horse racing experts entered their horses into races of a certain distance too many times. The result of this investigation shows experts' judgements of horses' performance. By using experts' judgements of horses' performance, we investigate why horse racing experts chose not to enter their horses in other similar-distance races. Finally, we associate the result with experts' race selection.

### *B. Detection of race distance and sire line combinations that horse racing experts selected too many times or too few times*

In order to detect cases where horse racing experts entered their horses of certain sire lines into races of certain distances too many times or too few times, we conduct the statistical analysis by using Hypothesis *ES*.

**Hypothesis *ES*** If experts did not enter too many times or too few times their racehorses of certain sire lines into races of certain distances, we would expect that experts entered their horses of sire line $s_i$ into races of distance $d_j$ at most $N_{ES}(s_i, d_j)$ times

$$N_{ES}(s_i, d_j) = P_{ES}(d_j) \times \sum_j N_{entry}(s_i, d_j) \qquad (1)$$

where $d_j$ is the type of race distance. We classified race distances into five types:

TABLE V
THE NUMBER OF HORSES OF FOUR SIRE LINES HAD COMPETED IN RACES OF VARIOUS DISTANCES.

| | race distance | | | | |
|---|---|---|---|---|---|
| sire line | 1000-1399m | 1400-1799m | 1800-2199m | 2200-2799m | 2800m- |
| Native Dancer | 5045 | 7135 | 5599 | 1269 | 574 |
| Nearctic | 3641 | 5102 | 4053 | 1005 | 395 |
| Royal Charger | 8807 | 14666 | 13074 | 3794 | 1320 |
| others | 2056 | 2844 | 2312 | 561 | 207 |
| Total | 19549 | 29747 | 25038 | 6629 | 2496 |

$d_1$ 1000 – 1399m
$d_2$ 1400 – 1799m
$d_3$ 1800 – 2199m
$d_4$ 2200 – 2799m
$d_5$ 2800m –

$N_{entry}(s_i, d_j)$ is the number of times horses of sire line $s_i$ were entered into races of distance $d_j$, as a result, $\sum_j N_{entry}(s_i, d_j)$ is the total number of times horses of sire line $s_i$ were entered into races. $P_{ES}(d_j)$ is the probability that an expert enters his/her horse into a race of distance $d_j$. $P_{ES}(d_j)$ is

$$P_{ES}(d_j) = \frac{\sum_i N_{entry}(s_i, d_j)}{\sum_i \sum_j N_{entry}(s_i, d_j)} \qquad (2)$$

where $\sum_i N_{entry}(s_i, d_j)$ is the total number of times horses were entered into races of distance $d_j$ and $\sum_i \sum_j N_{entry}(s_i, d_j)$ is the total number of times horses were entered into races.

If this hypothesis is rejected by an two-sided binomial test [20], we determine that experts entered their horses of sire lines $s_i$ into races of distance $d_j$ too many times or too few times.

### *C. Detection of horses that horse racing experts judged to have performed well*

If a horse perform well in a race of a certain distance, experts will try to enter the horse into another race of a similar distance. As a result, if horses are judged to have performed well in races of a certain distance, experts may enter them into other similar-distance races repeatedly. In order to detect cases where horse racing experts entered their horses into races of certain distances too many times or too few times, we conduct the statistical analysis by using Hypothesis *EJ*.

**Hypothesis *EJ*** If an expert did not enter too many times or too few times his/her racehorse of a certain sire line into races of a certain distance, we would expect that the expert entered horse $h_k$ into races of distance $d_j$ at most $M_{EJ}(h_k, d_j)$ times

$$M_{EJ}(h_k, d_j) = P_{EJ}(s_i, d_j) \times \sum_j M_{entry}(h_k, d_j) \qquad (3)$$

where $s_i$ is the sire line of horse $h_k$ and $d_j$ is the type of race distance. We classified race distances into five types in the

TABLE VI
THE P-VALUES OF EXPERTS' RACE SELECTIONS FOR HORSES OF NATIVE DANCER LINE.

| sire line | race distance | | | | |
|---|---|---|---|---|---|
| | 1000–1399m | 1400–1799m | 1800–2199m | 2200–2799m | 2800m– |
| Native Dancer | 1.0000 | 0.3024 | 0.0000 | 0.0000 | 0.0825 |

same way that we did in Hypothesis *ES*. $\sum_j M_{entry}(h_k, d_j)$ is the number of times horse $h_k$ were entered into races. $P_{EJ}(s_i, d_j)$ is the probability that an expert enters his/her horse of sire line $s_i$ into a race of distance $d_j$. $P_{EJ}(s_i, d_j)$ is

$$P_{EJ}(s_i, d_j) = \frac{N_{entry}(s_i, d_j)}{\sum_j N_{entry}(s_i, d_j)} \quad (4)$$

where $N_{entry}(s_i, d_j)$ is the number of times horses of sire line $s_i$ were entered into races of distance $d_j$. As a result, $\sum_i N_{entry}(s_i, d_j)$ is the total number of times horses were entered into races of distance $d_j$.

If this hypothesis is rejected by an two-sided binomial test [20], we determine that an expert entered horse $h_k$ of sire lines $s_i$ into races of distance $d_j$ too many times or too few times.

### D. Results of the investigation

In order to investigate why horse racing experts chose not to enter their horses in other similar-distance races, we apply Hypothesis *ES* and *EJ* tests on the 8799 horses of Native Dancer Line registered with JRA from 2010 to 2017, as shown in Table I. The significance levels for Hypothesis *ES* and *EJ* were 0.05. First, we calculated the p-values of experts' race selections and experts' judgements of horses' performance by applying Hypothesis *ES* and *EJ*, respectively. Table VI shows the p-values of experts' race selections for horses of Native Dancer Line. Table VII and Table VIII show the number of horses of Native Dancer Line determined by Hypothesis *EJ* to and not to have repeatedly competed in races of various distances, respectively, and also show the number of times the horses had competed in the races and the average number and the Standard Deviation (SD) of them.

First, we consider experts' expectations that their race selections suggested. Table VI, the results obtained by applying Hypothesis *ES*, shows that the p-value of race distance type $d_1$ (1000 – 1399m) was more than 0.975. As a result, experts entered horses of Native Dancer Line into races of distance type $d_1$ (1000 – 1399m) too many times. In other words, many experts strongly thought horses of Native Dancer Line were favorable to win in races of distance type $d_1$ (1000 – 1399m). On the other hand, the p-values of race distance type $d_3$ (1800 – 2199m) and $d_4$ (2200 – 2399m) were less than 0.025. As a result, many experts strongly thought horses of Native Dancer Line were unfavorable to win in races of distance type $d_3$ (1800 – 2199m) and $d_4$ (2200 – 2399m).

Next, we consider why experts chose not to enter their horses in other similar-distance races. There are many reasons

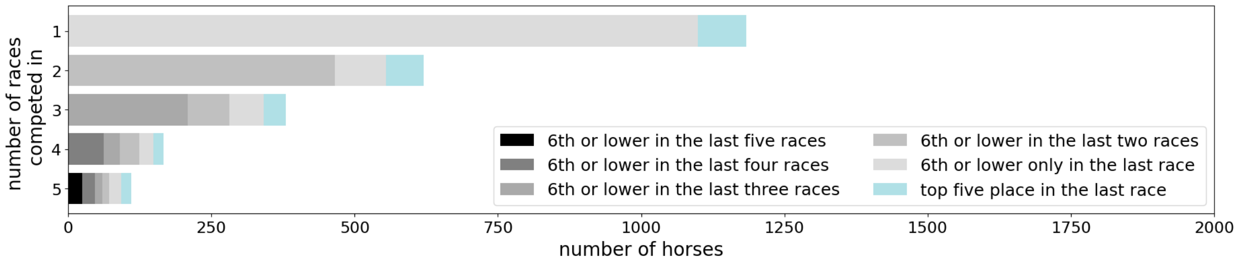
TABLE VII
THE NUMBER OF HORSES DETERMINED BY HYPOTHESIS *EJ* TO HAVE REPEATEDLY COMPETED IN RACES AND THE NUMBER OF RACES THEY HAD COMPETED IN.

| | race distance | | | | |
|---|---|---|---|---|---|
| | 1000-1399m | 1400-1799m | 1800-2199m | 2200-2799m | 2800m- |
| horses competed repeatedly | 2320 | 1575 | 1940 | 628 | 376 |
| races competed in | 20005 | 13491 | 18207 | 3308 | 2248 |
| ave. of races competed in | 8.6 | 8.6 | 9.4 | 5.3 | 6.0 |
| SD of races competed in | 7.7 | 7.4 | 7.6 | 5.2 | 5.0 |

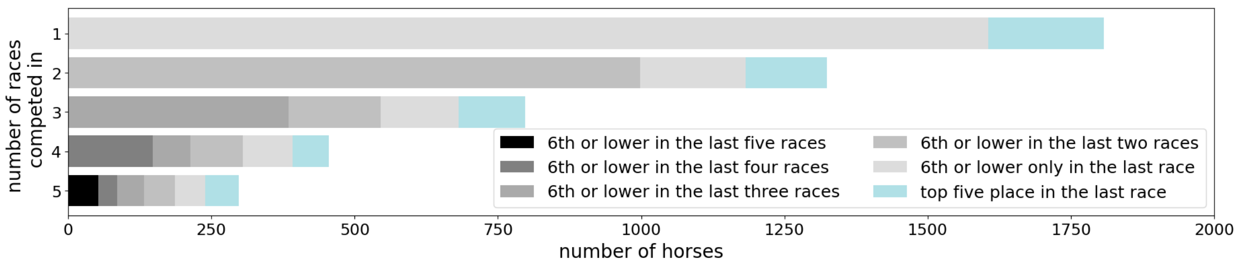
TABLE VIII
THE NUMBER OF HORSES DETERMINED BY HYPOTHESIS *EJ* NOT TO HAVE REPEATEDLY COMPETED IN RACES AND THE NUMBER OF RACES THEY HAD COMPETED IN.

| | race distance | | | | |
|---|---|---|---|---|---|
| | 1000-1399m | 1400-1799m | 1800-2199m | 2200-2799m | 2800m- |
| horses competed not repeatedly | 2725 | 5560 | 3659 | 641 | 198 |
| races competed in | 7003 | 18128 | 10361 | 865 | 263 |
| ave. of races competed in | 2.6 | 3.3 | 2.8 | 1.3 | 1.3 |
| SD of races competed in | 2.3 | 3.0 | 2.7 | 0.7 | 0.6 |

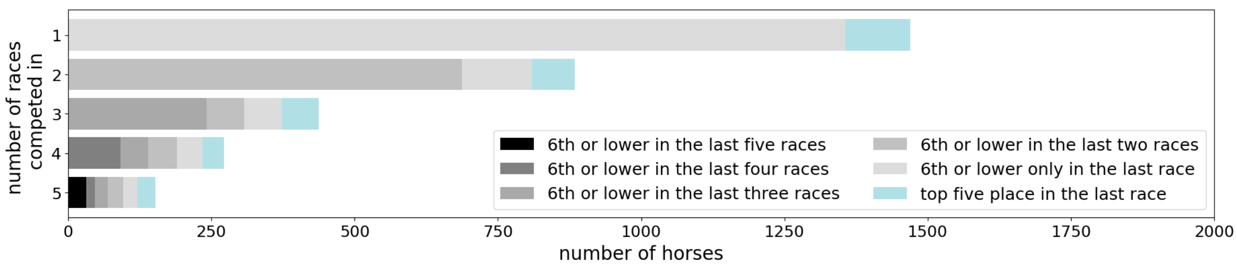
why experts chose not to do it. However, horses' performance was an important factor in experts' decisions, especially underperforming horses. As a result, we surveyed horses of Native Dancer Line determined by Hypothesis *EJ* not to have repeatedly competed in races of a certain distance and examined how many consecutive races they had finished in sixth place or lower, including their last races. The reason we focused on sixth place is because no prize money is offered when a horse finishes in sixth place or lower in races held by JRA. Figure 2 shows the number of consecutive races in which the horses competed in races of a certain distance five or fewer times finished in sixth place or lower, including their last races. Figure 2 shows that, in all race distances, there were not many horses that finished in fifth place or higher in their last races. We think that it is difficult for experts to choose not to enter their horses in other similar-distance races after they finished in fifth place or higher in the most recent races and won the prize money. On the other hand, the most common case was that horses that finished in sixth place or lower in their first races of a certain distance never competed in races of that distance again. This is the most common case even in races of distance type $d_2$ (1400 - 1799m) where the average number of races competed in was 3.3, as shown in Table VIII. As a result, many experts chose not to enter their horses in other races of certain distances when they finished in sixth place or lower in their first races of that distance. Next, we consider horses competed in races two or more times. Figure 2 shows that, for horses that had competed in races two or three times, the most common case was that they never finished in the top five in the races. In other words, many experts chose not to enter their horses in other races of a certain distance when their horses finished in sixth place or lower in the two or three consecutive races of that distance. For horses that had competed in races four or five times, the most common case



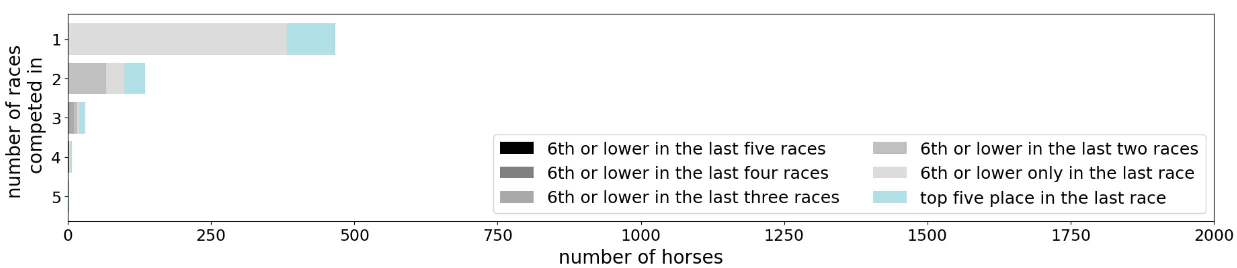

(a) race distance: 1000 – 1399m



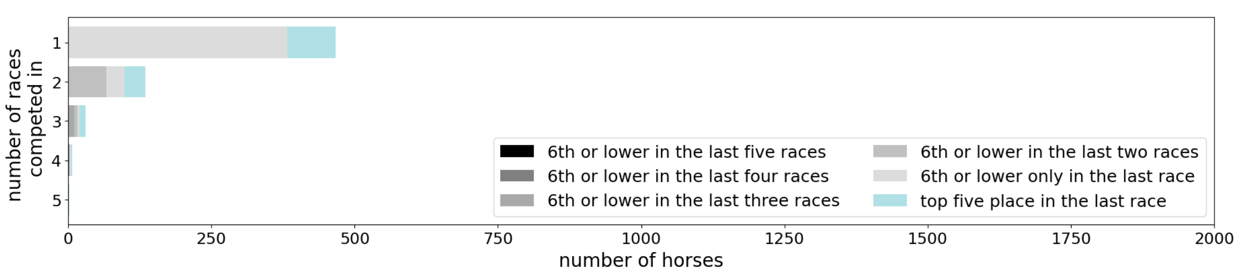

(b) race distance: 1400 – 1799m




(c) race distance: 1800 – 2199m




(d) race distance: 2200 – 2799m




(e) race distance: 2800m –

Figure 2. The number of consecutive races in which horses of Native Dancer Line that competed in races of a certain distance five or fewer times and were determined by Hypothesis *EJ* not to have repeatedly competed in races of that distance finished in sixth place or lower, including their last races.



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was still that they never finished in the top five in the races. However, the other common case was that horses finished in sixth place or lower in the last two or three races, not every race. Furthermore, for horses that had competed in races six or more times, the most common case was that horses finished in sixth place or lower in the last two or three races, not every race. In summary,

- it is most likely that experts chose not to enter their horses in other races of a certain distance when their horses finished in sixth place or lower in their first races of that distance.
- it is also likely that experts chose not to enter their horses in other races of a certain distance when their horse finished in sixth place or lower in the last two or three consecutive races.

The point to note is that, even if the race distance was different, the timing of when many experts chose not to enter their horses in other similar-distance races was not much different. For example, Figure 2 shows that the timing of when many experts chose not to enter their horses of Native Dancer Line in other similar-distance races was not much different whether the type of race distance was $d_1$ (1000 – 1399m) or $d_3$ (1800 – 2199m). However, many experts strongly thought horses of Native Dancer Line were favorable to win in races of distance type $d_1$ (1000 – 1399m) while they were unfavorable to win in races of of distance type $d_3$ (1800 – 2199m). As a result, it is possible that many experts did not consider sire lines when choosing whether or not to enter their horses in other similar-distance races as they do when selecting race distance.

## V. Conclusion and Future Work

In this paper, we investigated why horse racing experts chose not to enter their horses in other similar-distance races. We analyzed sire lines, race distances, and race results of the 36922 horses statistically and showed that many horse racing experts chose not to enter their horses in other races of any distance when their horses finished in sixth place or lower in the first races or the two or three consecutive races of that distance. The result of the investigation suggested that many horse racing experts did not consider sire lines when choosing whether to enter their horses in other similar-distance races as they do when selecting race distance. To generalize this finding, we intend to analyze race performance data from other time periods and compare the results with those obtained in this study.

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