TECHNOLOGY PROBLEMS IN THE OLYMPIC TRACK START: WHEN THE WINNER DOES NOT NECESSARILY WIN

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INTRODUCTION

It takes the sound of the starter's gun some time to travel from the gun to the athletes in the starting blocks. In the 1970s, a special starting system was devised to minimize this time. A microphone picked up the sound of the gun report, and transmitted the sound's electrical signal through a wire to loudspeakers in the starting blocks. At 30 degrees Celsius, sound travels through the air at 349 m/s, but electricity travels at the speed of light (300 million m/s). Therefore, this starting system should, in effect, allow all the athletes to hear the starter's shot simultaneously, immediately after the gun is fired. We will call this the loud gun system.

A different system was developed in the 1990s. In this system, the gun made no sound at all. Instead, the action of the trigger delivered an electrical impulse through a wire to loudspeakers in the starting blocks. The speakers then emitted a loud "ping", the signal for the athletes to start the race. This is called the silent gun system.

In theory, both systems should work equally well. However, in practice this is not the case. The silent gun system works as expected, but the loud gun system does not. When the loud gun system is used, the athletes generally behave as if a simple pre-1970 system were being used, with no functioning microphone, wires nor loudspeakers. This problem was first noticed by Lennart Julin (1997, 2001).

The World Championships have switched to the silent gun system, but the Olympic Games continue to use the older (and non-functioning) loud gun system.

I realize it's hard to believe that the starting system used regularly in the Olympic Games does not work properly, but the evidence is clear, as I will show below. We will begin with a fairly detailed analysis of the 4x100 start times. Then we will look at the rest of the races that use starting blocks.

THE 4x100

The 4x100 has several features that make it ideal for the analysis of possible problems in the starting system: (1) The large staggers put the athletes at very different distances from the starter's gun; (2) The athletes are all 100-meter sprinters, eager to get in motion in the minimum possible amount of time after they hear the gun, which may result in greater consistency in the reaction to the gun than in races involving 400-meter runners.

I will make comparisons using start time data from three meets: the 1995 World Championships at Göteborg (silent gun), the 1996 Olympic Games at Atlanta (loud gun), and the 2004 Olympic Games at Athens (loud gun).

Göteborg 1995 (silent gun)

Throughout this study, we will be looking at *median* start times for each lane. To obtain the median, you put all the times in order from the smallest one to the largest one, and pick the one in the middle. (If there is an even number of times, you calculate the average of the two

times in the middle.) The median is more useful for our purposes than the mean because it helps to prevent some occasional wayward times from distorting the results too much.

The graph in Figure 1 shows the median starting times for all the lanes of the men's 4x100 in Göteborg. The start times were similar for all the lanes. This is what we would expect from a good starting system.

Atlanta 1996 (loud gun) vs. Göteborg 1995 (silent gun)

The graph in Figure 2 shows the median start times for the men's 4x100 in Atlanta, with the Göteborg times left in for comparison purposes.

All the lanes had longer start times in Atlanta than in Göteborg. The graph also shows a progressive increase in the start times with increasing lane number. All this is consistent with the hypothesis that, in Atlanta, the sound traveled from the gun to the athletes only through the air, and not through the loudspeaker system.

Knowing the positions of the starter and of the athletes, and knowing the speed at which sound travels through the air, we can calculate how long it took the sound of the gun to travel through the air to each athlete. If we add this to the average start time from Göteborg, we can

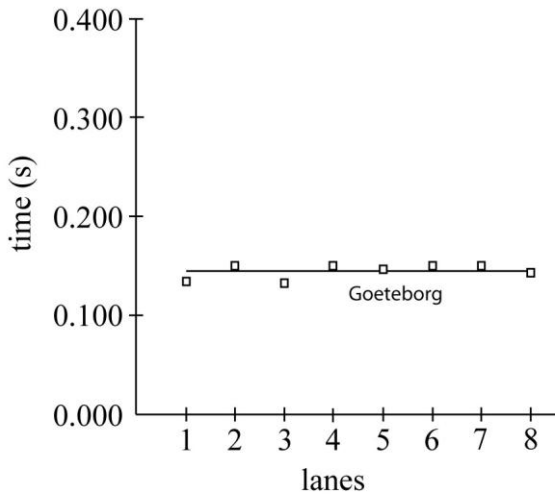

Figure 1.

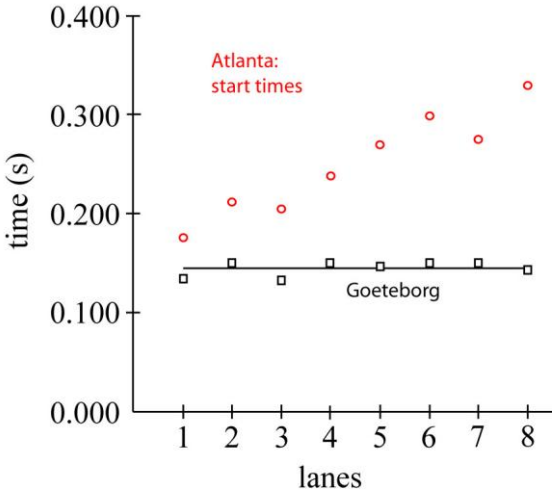

Figure 2.

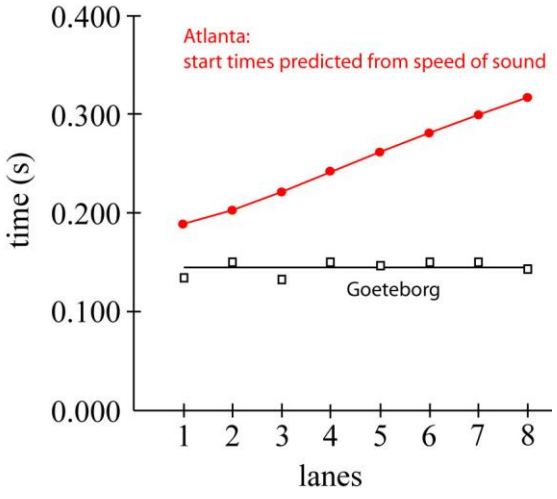

Figure 3.

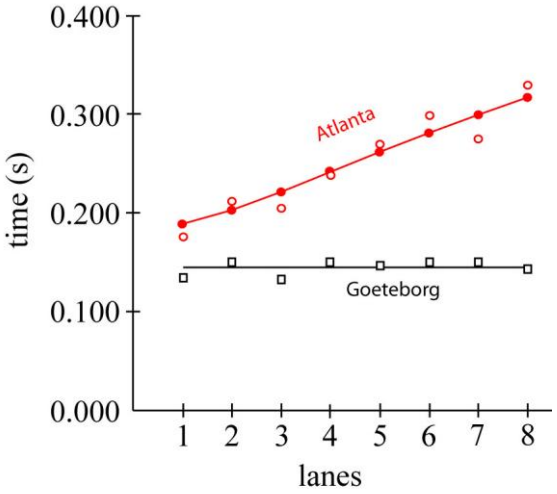

Figure 4.

predict an expected start time for each lane in Atlanta. In other words, we can calculate what times would have been expected in Atlanta if the athletes had heard the gun only through the air. These expected times are shown in Figure 3.

The graphs in Figures 2 and 3 can be superimposed on each other: The resulting graph (Figure 4) shows that there is a very close fit between the actual start times from Atlanta and what we would have expected to find if the speakers did not work.

(For a more detailed description of this analysis of the Atlanta and Göteborg times, see Julin and Dapena, 2003.)

Athens 2004 (loud gun) vs. Göteborg 1995 (silent gun)

Now, we will repeat the process for Athens. The Athens 4x100 presents some difficulties for our analysis. Tougher qualifying standards limited the competition to only two rounds in Athens, a total of three races. This reduced the number of times available for each lane, which in turn increased the possibility that random variation in the true reaction times of different athletes might distort the underlying relationship between lane number and start time. To increase the number of times available, I pooled the data from the men's and women's 4x100 races. (Before doing this, I first checked the starting times for men and women in the last three rounds of the 100 at the Paris World Championships in 2003, a silent gun meet. The median start time was just 0.004 seconds longer for the women than for the men. The small size of this difference made it acceptable to pool the men's and women's 4x100 start times from Athens after subtracting 0.004 seconds from all the women's start times.)

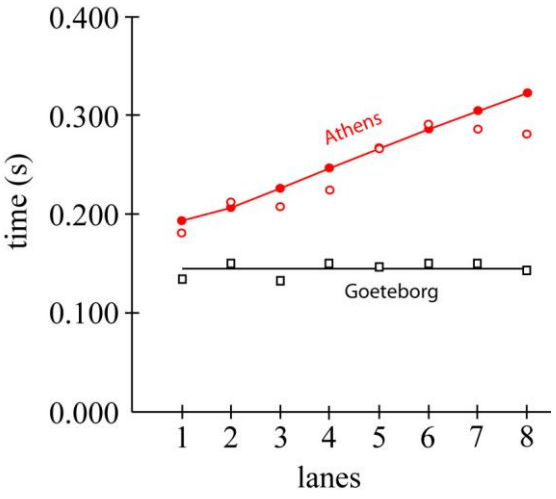

Figure 5.

The graph in Figure 5 shows the pooled men's and women's 4x100 data from Athens. It shows essentially the same pattern for Athens that the previous graph showed for Atlanta: All lanes had longer start times in Athens than in Göteborg, and there was a progressive increase in the start times with increasing lane number. The pattern of the median 4x100 times in Athens (hollow red circles) fit reasonably well with what would have been expected from the speed of sound and the hypothesis of non-functioning loudspeakers (solid red circles). The fit was not quite as good as in Atlanta, probably due to error in the estimate that I used for the average position of the starter in Athens. (I was not able to find good photos of the starter in all six 4x100 races.)

OTHER ATHENS 2004 RACES

The problem in the starting system was not limited to the 4x100. We will see next that it occurred in all the staggered races, and in at least two of the four races run in the final straight.

I could not make any comparisons of Athens with Göteborg other than for the 4x100, because that was the only race for which I had data available from Göteborg. Therefore, all the

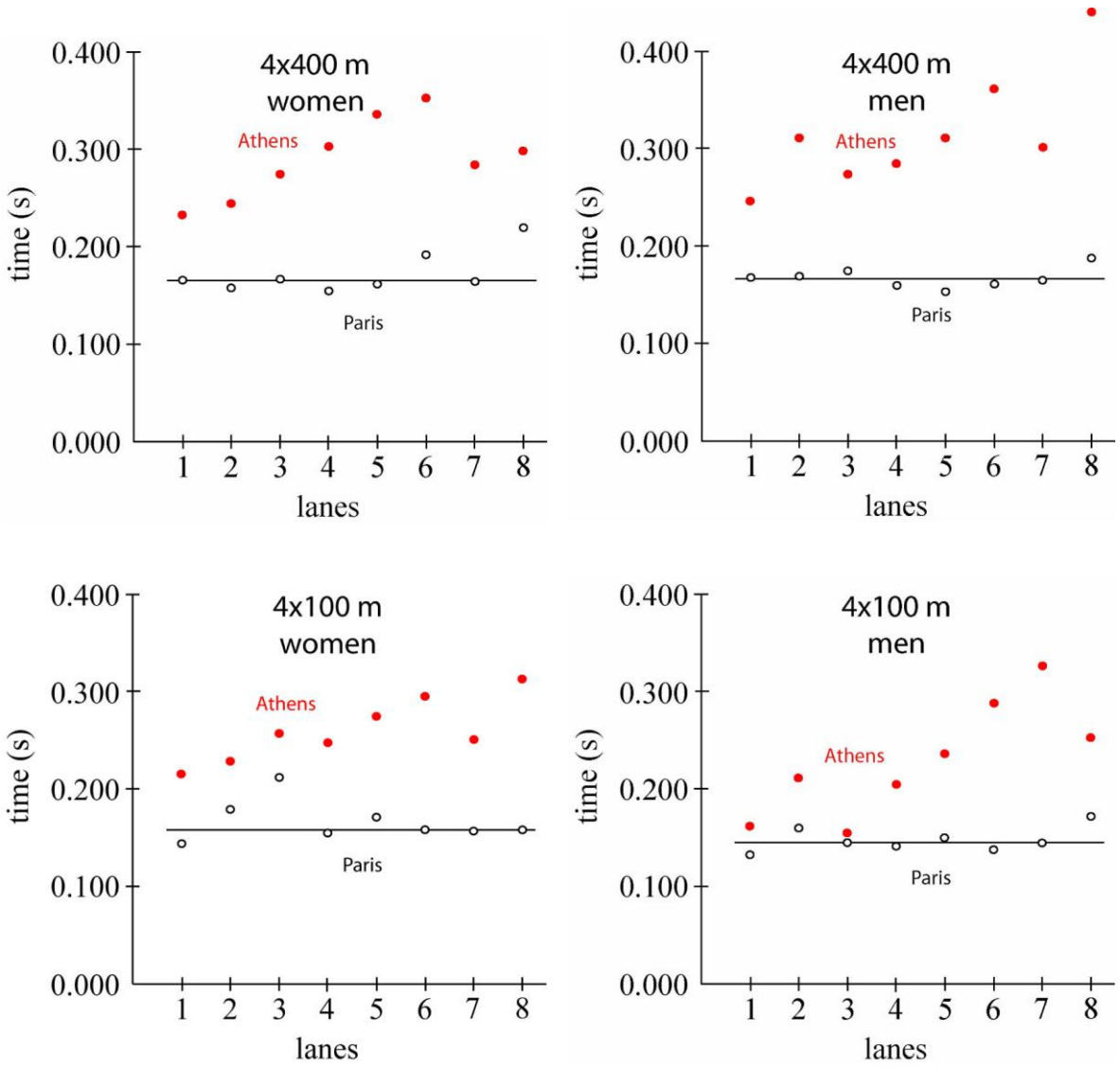

Figure 6.

comparisons that follow are between Athens 2004 and the Paris World Championships of 2003 (a meet that used the silent gun system, like Göteborg).

The graphs in Figures 6 and 7 show all the races that involved a staggered start. For reference, I drew in each race a horizontal line at the median of the Paris medians. Every single one of these races showed a longer average start time in Athens than in Paris, and a clear upward trend with increasing lane count in Athens. The effects were largest for the 4x400 relay, and smallest for the 200, with the 4x100, 400 and 400H somewhere in between. Given that the 4x400 relay has the longest staggers and the 200 the shortest ones, the patterns shown in these graphs were consistent with the hypothesis that the differences between Athens and Paris were due to a starting system that did not transmit the sound of the gun properly through the loudspeakers in Athens.

The unstaggered sprint races (100, 100 hurdles and 110 hurdles) are shown in Figure 8. In these races, it also takes a longer time for sound to reach the athletes in the outer lanes.

However, the time disadvantages should be quite small, because they will be due only to differences in distance across the track, and not to the much longer distances along the track that

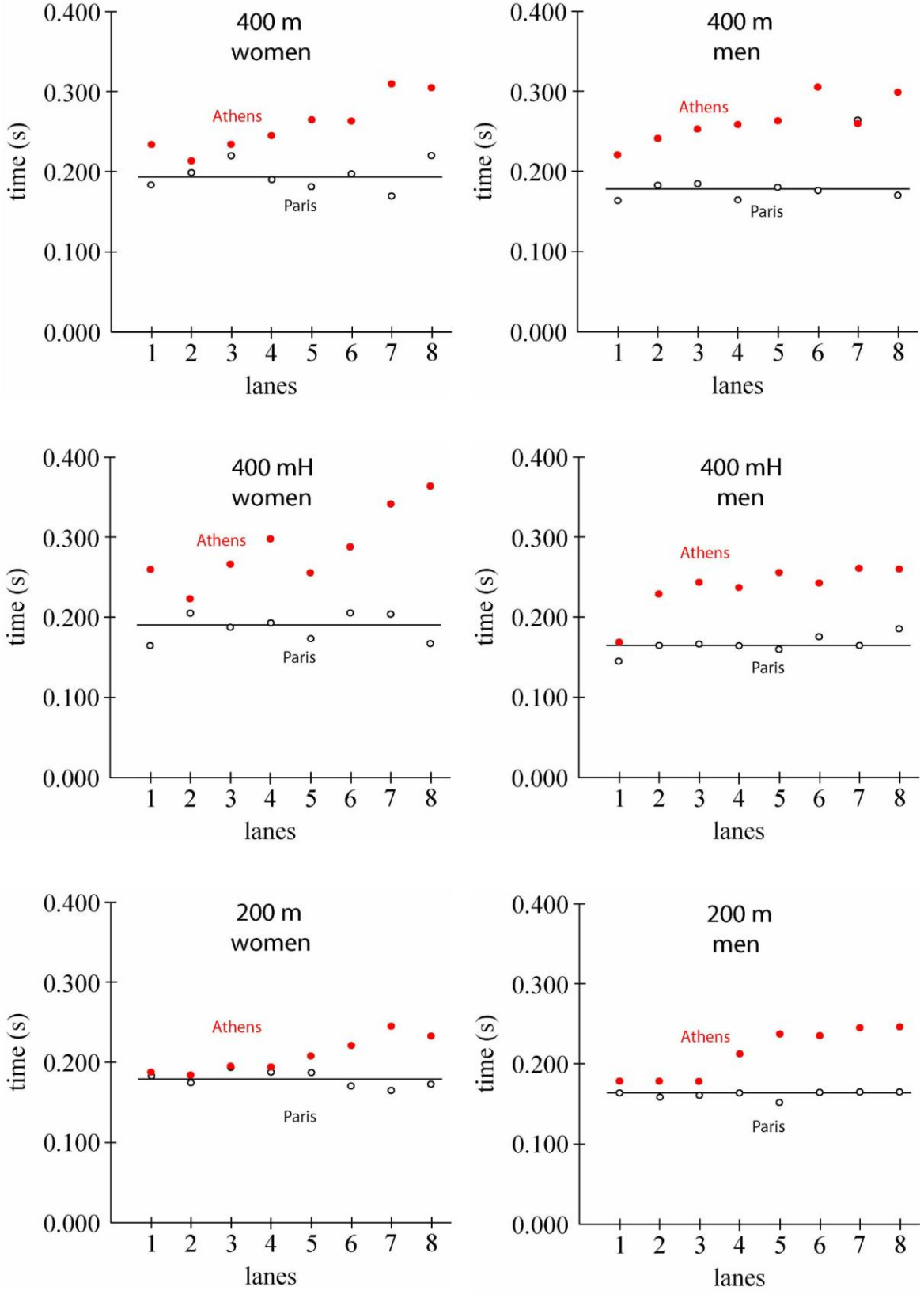

Figure 7.

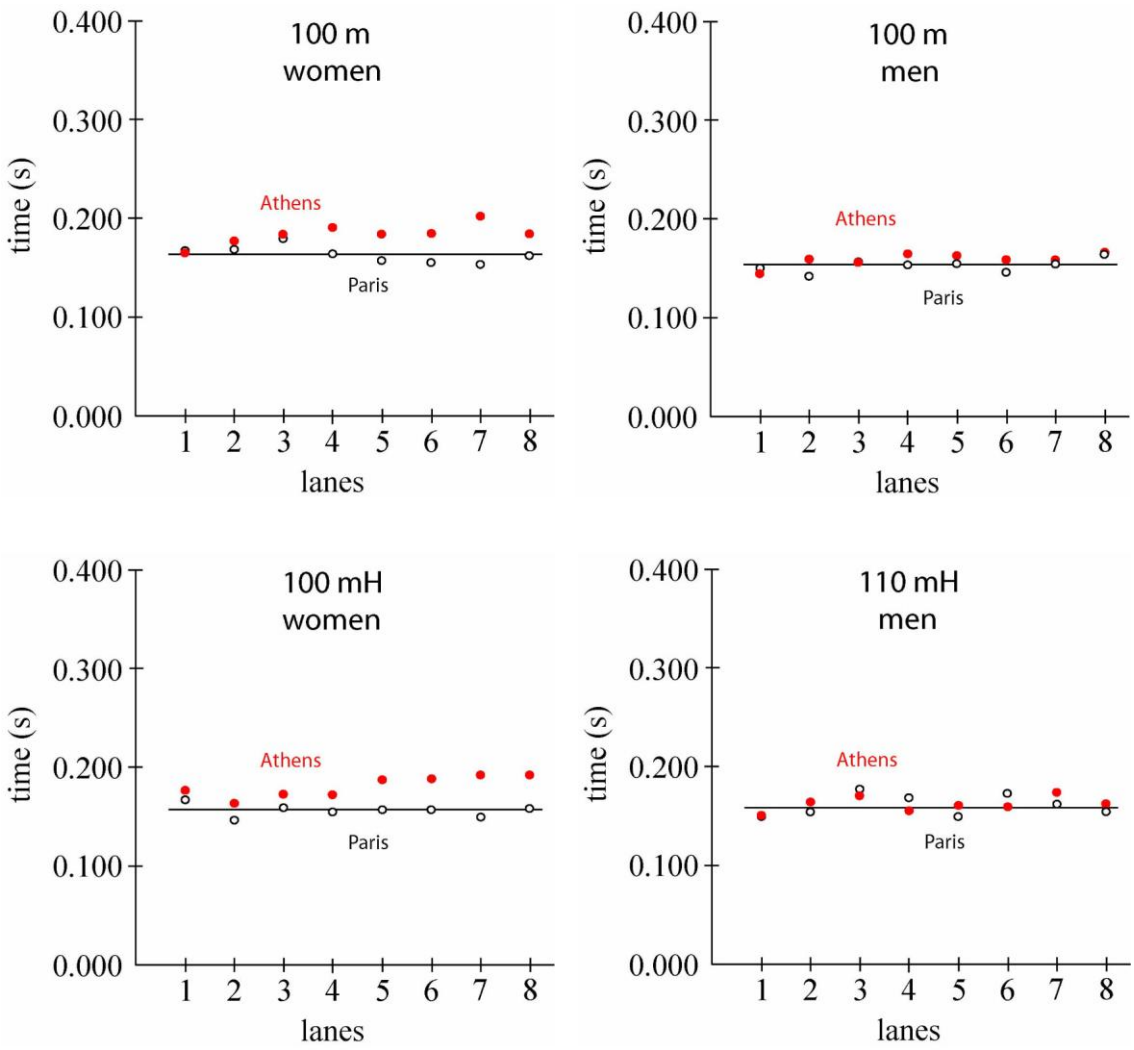

Figure 8.

generally result from staggered starts.

The two women's races showed a slightly longer average start time in Athens than in Paris, and a slight upward trend with increasing lane count in Athens, and these effects were smaller than in the 200. All of this fit quite well with what should be expected from a malfunctioning starting system in Athens. On the other hand, the men's 100 and 110 hurdles showed little difference between Paris and Athens. This suggests that the Athens starting system may have actually functioned properly in these two races.

CONCLUSIONS

The comparison of the 4x100 start times from Atlanta, Athens and Göteborg showed that the differences between the patterns produced by the Atlanta and Athens start times on one hand, and by the Göteborg start times on the other, were consistent with what would be expected if the loud gun starting system used in Atlanta and Athens did not deliver any sound to the speakers in the starting blocks. The comparison of the start times from Athens and Paris in all the races that

used starting blocks showed that in Athens the starting system malfunctioned in 12 out of these 14 races, including all the races with staggered starts. The system seemed to work only in the men's 100 and 110 hurdles. It is unclear why the starting system may have worked properly in these two races when it did not work in any of the others.

In theory, the loud gun system should work, and I don't know why it does not. With the information available at this time, any explanation of the possible reasons for the problem would have to be speculative.

One thing that we do know is that the symptoms described here have also been observed at various other loud gun competitions, including competitions that used different brands of loud gun systems. (See Julin and Dapena, 2003.) This indicates that the problem is not the result of an isolated equipment malfunction, and suggests that it may be inherent to all current implementations of the loud gun system.

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