Impact of drafting in swimming races

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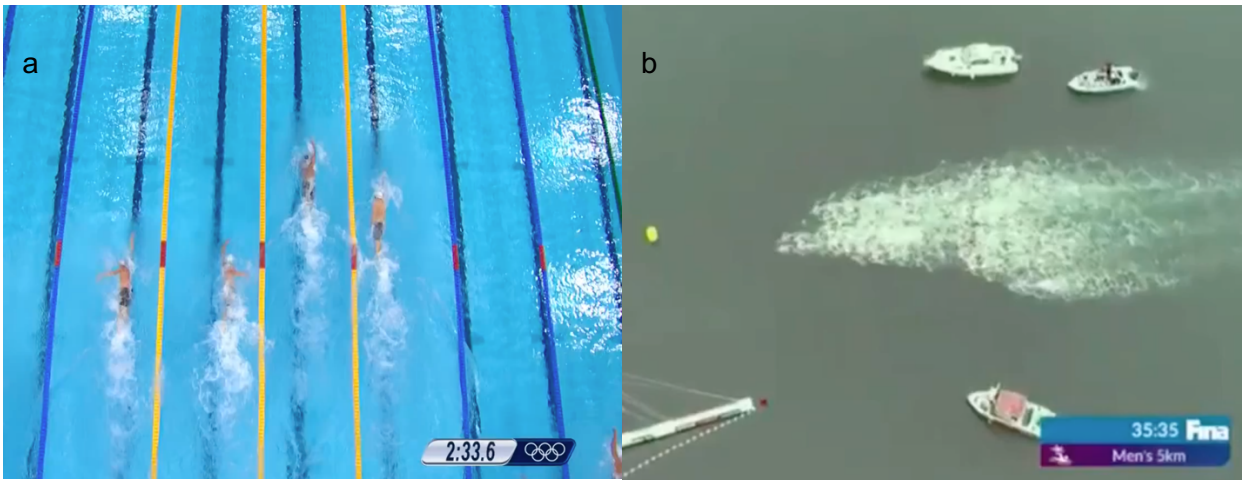

Figure 1 : (a) Pool swimming race (b) Open water peloton

Contexte & description:

In competitive swimming, swimmers can interact with each other (figure 1). This interaction can be positive (reduction of the water resistance compared to isolated swimmer case) or negative. Athletes could play on these effects to facilate passing of an oponent or conversaly to penalize a passing oponent. The goal of this project is to study the drag on modelled swimmers (complex form hulls) in different formations and positions and see if there exists preferential routes for passing or strategies to impede passing of oponents. The project will also look at the drag in peloton formations (figure 1 b).

Previous studies [1-8] have already looked at this effect called "drafting". It is not limited to swimming. It also exists in biking, skiing, running and of course car racing among other sports. One of the major difference in drafting in swimming is the fact that this occurs near a water-air interface which leads to an interesting wave pattern interactions and complexifying the drafting physics.

Studies in biomechanics [1-3] have shown that the drafting was significative on swimmers (reduction of drag and VO2). Millet *et al.* (2000) [1] looked at the impact of leg kicking on triathlete swimmer drafting while swimming in line (case $\theta = \pi/2$ in figure 2-b). They concluded that leg kicking frequency did not have a significant impact on drafting. They found interestingly that swimmers with higher passive drag (drag while being towed passively) chose to swim closer to a lead swimmer (maybe to experience a more significant drag reduction). Chatard *et al.* (2003) [2] and Janssen *et al.* (2009) [3] studied drafting between two swimmers in a flume. In both studies, two configurations were investigated (in line $\theta = \pi/2$ and r cos θ = cte as defined in figure 2-b). They showed that the configurations lead to different results but the number of positions were limited. They also showed that the experienced benefits of drafting (mainly VO2 consumption) was linked to the passive drag reduction measured. Recently, Westerweel *et al.* (2016) [4] looked at drafting for passive reduced modelled swimmers. They found regions where a passive swimmers experienced an increased drag near a lead swimmer. These regions can be interpreted as zone to avoid when passing a swimmer or a zone to exploite to impede passing. A recent numerical [5] study looked at the drafting in a potential approximation and shown the role of the water interface on drafting. The general impact of swimming lane ropes on drafting is still to be explored.

The present postdoctoral project is organized around two main parts.

In first part will investigate drafting in open water races. In this case, swimmers can form "peloton"(see figure 1-b) similarly too biking. The objective will be to first study the interactions of 2 swimmers in different formations (see figure 2 b) and then considered peloton like formation. The effect of arm rotation will be ignored at the beginning but it will be interesting to add this effect in the experiments later on.

The second part will considered the impact of swimming lane ropes on water resistance. First an isolated swimmer will be considered and different lane spacing. Then a two-swimmers configuration will be considered.

This project is part of the **ANR NePTUNE** in collaboration with the French Swimming Federation (FFN, Federation Francaise de Natation) and the French Parasport Federation (FFH, Federation Francaise Handisport). The candidate will interact with the coaches and athletes concerned by the results and will be involved in the general project. The NePTUNE project is organized arount three axes: pacing strategies, motor coordination and water resistances. This position is part of the third axe. The position is for a maximum of two years. Interactions and involvement in other parts of the general project is possible throughout the 2 years position. The candidate will also have the opportunity to enroll and manage master students interns during their time in the team. The experiments will be conducted at the LHSV in Chatou and LadHyX in Palaiseau, both near Paris, France.
This project is also part of the **SCIENCES[2024]** project.

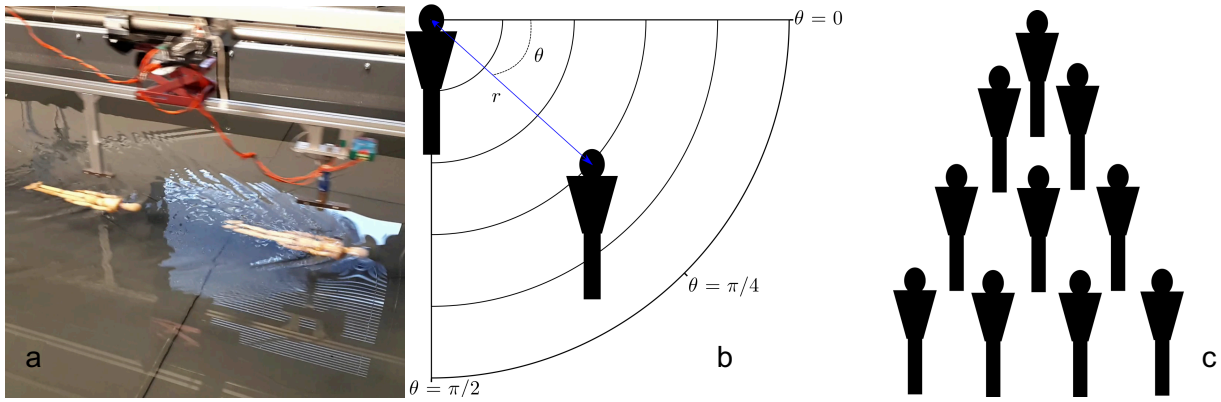

Figure 2 : a) Preliminary experiment of drafting in line, b) notations and definitions, c) peloton formations.

Keywords : swimming, drafting, water drag, waves, experimental fluid mechanics

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Locations:
The candidate will conduct the experiments at the LHSV in Chatou and LadHyX in Palaiseau.
Required skills :
The candidate must have solid training in fluid mechanics, and experience(s) in experimental research in the laboratory. Knowledge of electronics/biomechanics/physiology, notions of machining and a good level in French would be a plus.
Starting date and duration : as soon July 1st 2020 and for 2 years.
Funding: Approved

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