Paralympic sprinters’ prostheses impair curve-running performance

A Paralympic sprinter. Photo credit: Applied Biomechanics Lab.

The debate about Paralympic athletes competing against able-bodied athletes has raged since before Oscar Pistorius took to the track on his Flex-Foot Cheetah prosthetic leg at the London Olympics in 2012. Some biomechanists suggest that prosthetic limbs give Paralympians an unfair advantage, while others argue that prostheses restrict athletes as they power away from the blocks. ‘When I saw Paralympians using these devices I said, “I really want to understand how these prostheses function during sprinting”’, recalls Paolo Taboga, from the University of Colorado, USA. All of the previous studies had investigated sprinters running straight, however, 200 m and 400 m competitions are run on curves. ‘We wanted to see what happens for these athletes with unilateral [one-sided] amputations when they run on a curve’, explains Taboga, who teamed up with Rodger Kram and Alena Grabowski to learn more about the effects of prostheses on cornering.

However, instead of testing local recreational runners, the scientists aimed for the top and recruited members of the US and German Paralympic teams. ‘It’s like in Formula 1 races – you push the limits of cars’, smiles Taboga, who wanted the athletes to give their prosthetic limbs the ultimate workout as they sprinted around a flat curve on an indoor track.

The scientists flew athletes with left and right below-the-knee amputations to the University of Colorado Boulder, where they asked the sprinters to run at top speed around a 17.2 m radius curve in both the clockwise and anti-clockwise directions as they filmed the trials. Taboga admits that running around the clockwise curve was challenging. ‘Nobody trains to run in that direction, so it is a bit weird’, he says, remembering that everyone eventually got the knack.

However, when the team analysed the sprinters’ performances, they were surprised to discover that the athletes that were running with their prosthesis on the inside of the curve were 4% slower than the athletes that were sprinting with the prosthesis on the outside. ‘It was a measurable difference’, says Taboga, adding that this could add up to two-tenths of a second to a sprint over 200 m. ‘That means you could win the race, or get fourth and not even get on the podium’, shrugs Taboga.

Admitting that the extent of the impairment was unexpected, Taboga explains that Paralympic sprinters produce less force when running straight, which probably means that the force is also reduced when they go around a bend. In addition, the athletes slowed more as they took the curve with the affected leg on the inside. ‘So you have two limiting factors that sum up’, he says. And when he broke the news to the athletes, Taboga recalls, ‘A lot of athletes with a left leg amputation said, “Oh yes, when I have to run on curves I don’t really like running in lane 1 or 2”’.

But what does all this mean for sprinters competing at the next Paralympic Games? Taboga suspects that athletes with a left leg amputation may be slightly disadvantaged, although he adds ‘The calibre of the athletes is the main difference’. He suggests, ‘To make a fair competition, let the left leg amputees run on the outside, lanes 5–8’. And he is keen to design new prosthetic limbs that handle corners better. ‘Then people who don’t normally like prostheses will use them more and get more active, improving their quality of life’, he hopes.
and a starvation diet. Then she waited to see how well they fared.

However, Dussutour was in for a shock. ‘Usually we use foragers to do these studies because they are supposed to be older so they are supposed to die earlier’, she says. However, the foragers that were fed the optimal diet lived for almost as long as the inner nest workers, with one surviving an incredible 409 days while the last worker held out for 436 days. And some of the foragers on the well-balanced thin soup diet even survived for 300 days. However, the foragers on the high protein malnutrition diet struggled, only surviving an average of 21 days, and the foragers that were placed on a starvation diet were decimated. ‘They lasted a week and a half, but the inner nest workers survived for over 100 days’, says Dussutour. So, when their diet took a turn for the worse, the foragers were always the first to die, even though they were the colony’s sole supplier of nutrition.

But why did the foragers suffer first? Dussutour was puzzled: ‘We wondered if it was because they had different tasks or if it was because they were different ages’. Foragers are usually the oldest ants in the nest and workers are the youngest, so Dussutour used a cunning trick to create youthful foragers and elderly nest workers to test whether age or role was the cause of the forager’s demise. ‘Testing the ants’ longevity on a starvation diet, Dussutour was amazed to discover that the foragers always died first. ‘Even the foragers that were young died earlier than the inner nest workers that were old’, she says.

Having ruled out age as the cause of the foragers’ deaths, Dussutour wondered whether they were more vulnerable to starvation because they carry less fat than worker ants. She measured the fat content of foragers’ and workers’ bodies as they switched between roles, and no sooner had a worker switched to become a forager than its body fat content dropped to 15%. Meanwhile, the fat content of foragers that assumed a worker’s role rocketed to 30%. ‘The colonies that had consumed more carbohydrates were more fat and we were able to show that [for ants] the fatter you are the better it is for your survival,’ chuckles Dussutour.

So it seems that lean foragers die first when food is scarce, although Dussutour explains that foragers have to be skinny: ‘If they are not starving, they won’t be motivated to go out to forage’, she laughs.

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Prozac makes Siamese fighting fish timid

Hailed as a wonder drug since the mid-1980s, fluoxetine – the drug in Prozac – is on the World Health Organisation List of Essential Medicines. Used to treat human psychiatric disorders such as depression and post-traumatic stress disorder, fluoxetine is believed to increase levels of the neurotransmitter serotonin in the synapse between nerves by reducing reabsorption into nerve cells to relieve symptoms. But humans may not be the only animals on the doctor’s prescription. Teresa Dzieweczynski and colleagues from the University of New England, USA, explain that the drug is turning up in our river systems, thanks to its resistance to breakdown, and seems to be affecting the behaviour of aquatic residents, reducing aggression and risk-taking, and affecting how often animals feed. But little is known about the longer-term effects of exposure or how the drug may alter behaviour in different settings. As female Siamese fighting fish are known to be less aggressive and inquisitive after a dose of the drug, Dzieweczynski and her colleagues Brennah Campbell and Jessica Kane decided to find out how male Siamese fighting fish that had not been exposed to the fluoxetine and those that had experienced a week-long low (0.5 μg l⁻¹ – similar to the levels found in effluent water) or high dose (5 μg l⁻¹ – similar to levels found in body fluids of human patients) of fluoxetine responded to situations that were designed to challenge their courage, and how their reactions changed over time.

Right from the start, it was clear that fish that had not been exposed to fluoxetine were much keener to explore a novel empty tank than the fish that had been swimming in water laced with the antidepressant, and the fish that had received the highest dose were the most timid. However, the fish that had been exposed to 0.5 μg l⁻¹ of the drug were bolder on some occasions than others. And when the team tested the fish’s reactions to an unfamiliar tank furnished with intriguing stones and plants, or the presence of a shoal of lady Siamese fighting fish, the two sets of drugged males were equally disinterested in exploring; the strength of the drug did not affect them differently. The team says, ‘Perhaps most importantly and alarmingly, the effects of exposure lasted even after fluoxetine was removed’, and they warn, ‘Even brief periods of exposure could potentially produce chronic effects, especially as boldness is important in migration, aggression and predator evasion’.

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