A Post-polio Paraplegic Couple: A Woman With Palmigrade, Saltatoric Locomotion; A Man With Inability To Walk; A Dynamical Systems Theoretical Perspective

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Abstract

A couple with post-polio paraplegia was presented in the current work. The man and woman were quite normal in the psychomotor domain except that each had two paralyzed legs. The woman also had a strong palmo-mental reflex. MRI scans showed no abnormalities in the cerebro-cerebellar structures. The woman exhibited habitual saltatoric palmigrade locomotion, while the man was always sitting without locomotion, using a wheelchair to move around. The woman rejected all offers of devices to help her move around, and strongly preferred walking on all fours while jerking the legs forward with the help of her back muscles. Despite having similar neurological deficits, the man and woman showed different attractors: a palmigrade locomotion on all fours in the woman, which apparently resulted from a spontaneous and randomly occurring self-organization process, while the man exhibited no transition from sitting to a walking state. It was suggested that (i) these different human beings with similar neurological deficits but different attractor states would provide good evidence for the random and unpredictable outputs of the self-organizing processes; (ii) the co-occurrence of a primitive reflex with a primitive walking style would be consistent with the theory of reverse evolution in human beings.

Introduction

The first case of post-polio palm-walking reported in the scientific literature was an English boy photographed in 1901 by Eadweard Muybridge (1830-1904). Muybridge used a zoopraxiscope to recreate movements by displaying individual photographs in rapid succession [1]. Illustration 1 depicts the locomotion of the child on all four extremities. Interestingly, this was a diagonal-sequence quadrupedal locomotion as also seen in the cases exhibiting Uner Tan syndrome (UTS) [2, 3]. This quadrupedal walking style is one of two kinds of quadrupedal locomotion: lateral versus diagonal. The first is usually used by non-primates, and the latter mainly by primates, including the quadruped human beings [3-7]. In diagonal-sequence quadrupedal locomotion a foot touches the ground followed by the contralateral hand and vice versa, while in lateral-sequence quadrupedal locomotion the foot touches the ground followed by the ipsilateral hand and vice versa [7].

Illustration 2 depicts the successive photographs of the child walking on all fours taken by Muybridge and published in 1901 [1]. A simulated motion from the same successive pictures was then created using Muybridge's zoopraxiscope. The publication of photographs of the child walking on all fours in 1901 created great interest in England, but they were controversial (was the boy human or animal?). One of the photographs of this child was later painted in 1961 by Francis Bacon: Paralytic Child Walking on All Fours (from Muybridge). The painting is described as: “a naked body on hands and feet is finding its way around a bare space.” (Gemeentemuseum, The Netherlands; Illustration 3). The painting was “inspired by Muybridge’s fascinating but shocking series of photographs.”

Paralysis of the legs generally occurs during an infantile polio infection. Millions of people have paralyzed leg(s) as a post-polio sequel, but extremely rarely some of them prefer palm walking on all fours. Above I have presented one of them, which created great interest — and controversy — in the community. More than a hundred years later, in 2007, I found a case in Adana, Turkey [2]: a tripedal-walking 36-year-old man with a paralyzed leg as a result of polio he contracted when he was two months old. He strongly preferred walking on all fours, rejecting every assistance to walk upright, including crutches and a wheelchair. He was a bright person, working at the American Air Base near Adana. His speech was fluent with a rich vocabulary. Except for a paralyzed leg, there were no neurological and psychological signs and symptoms; and his brain MRI scan did not show any abnormalities.

Two years later, in 2009, I found two similar cases...
near Bursa: one man in his 40s, and one woman in her 30s. Both had a paralyzed leg due to infantile poliomyelitis, but strongly preferred walking on all fours, rejecting every assistance to walk upright. Their cognitive abilities, including speech, were quite normal; they could walk and even run on all fours (actually on all threes) with great ease, and they were even able to rapidly ascend and descend staircases. The brain MRI scans were also normal. They did not exhibit any neurological and psychological signs and symptoms, except a paralyzed leg [3]. A fifth case, a 48-year-old man with a paralyzed leg due to childhood poliomyelitis, resided in a small village on the Aegean Sea coast, also habitually walked on all fours, i.e., tripedally [3]. He also rejected every assistance to walk upright, such as crutches or a wheelchair. He is a quite bright and lively person, and can run up staircases quickly. He works as a tourist guide, and has near-perfect English. His brain MRI scan seemed to be entirely normal.

Above I have presented five cases with a paralyzed leg as a result of polio acquired during babyhood. Only one was found in England, with the remaining four being in Turkey. Recently, I was informed by a friend about the existence of Uner Tan syndrome (habitual quadrupedalism, and impaired cognition including speech, intelligence and conscious experience) [3] in Konya, which is located in Anatolia. As I arrived there and encountered the couple (see illustration 4), I discovered they were both paraplegic and had two paralyzed legs due to infantile poliomyelitis. The woman habitually walked on her hands, with her legs not bent, being passive, and her feet touching the ground. The man was entirely unable to move around, despite having the same pathological condition.

Case Report(s)

The family consisted of the father (35-year-old), mother (34-year-old), and three children: two sons (11- and 8-year-old) and one daughter (8-year-old), who are all at school now and quite normal. The parents are not relatives, and there is no family history with regard to quadrupedalism. The mother had a polio infection when she was one year old. According to the mother’s mother, her legs were paralyzed after a penicillin injection. She was initially unable to move around, but at around two years of age she learned to walk on her hands, jerking the legs forward by using the back muscles. Since then, she has always preferred palm-walking and rejects using crutches to help her walk upright or a wheelchair to move around easily. Video 1 shows the habitual walking style of the woman, using both hands alternatively to move forwards, while jerking the paralyzed legs forward to follow the hands.

Illustration 5 depicts the sagittal (A, B) and coronal (C, D) MRIs of the brain for the man (A, C above) and woman (B, D). The cerebral and cerebellar structures including cerebellum (coronal section), cerebellar vermis (sagittal and coronal sections), corpus callosum, cerebral gyri,pons and bulbus (sagittal sections) seemed to be normal in these MRI scans. A neurological examination of the woman revealed she could not voluntarily move her lower extremities, and the leg muscles were severely atrophic and hypotonic. The touch sensation was normal. Except the position sense in the thumbs; the patella reflex could be elicited but only with a very weak response. The Babinsky sign was negative. The upper extremities were quite normal, with strong muscles, well developed tonus, normal deep tendon reflexes and normal coordination (successful rapid alternating movements and point to point movements). She could sit without any truncal instability ataxia. The palomental reflex was positive, being strong and not fatigable. The cranial nerves were normal, touch sensation and position sense were normal. There was no nystagmus. Her speech was normal with no dysarthria. She never went to school, but she was a bright person.

On neurological examination of the man, we found he also could not voluntarily move his legs, and the muscles were severely atrophic and hypotonic. Touch sensation and position sense in the thumbs were normal, but no deep tendon reflexes could be elicited. The Babinsky sign was negative. On the upper extremities, the deep tendon reflexes, muscle tonus and strength, touch sensation, and position sense on finger movements were normal. No palomental reflex could be elicited. There was no nystagmus. There was also no dysmetria, and coordination, including rapid alternating movements and point-to-point movements, were normal. There was no dysarthria. His speech was normal. He never went to school, but was a bright person. He usually did not move around, preferring sitting down, with his wife helping him at home. He uses a wheelchair for travel outside his home.

Discussion

In this case report I presented a couple with infantile post-polio paraplegia. Although both individuals were unable to stand up and walk upright due to their
paralyzed legs, they exhibited entirely different styles of locomotion. Namely, the woman used a saltatory, palmigrade locomotion, while the man was always sitting and could not walk at all, using a wheelchair to travel around.

The emergence of a saltatoric, palmigrade locomotion following post-polio paraplegia has not been reported previously elsewhere, making this the first case of such locomotion in a person with two paralyzed legs to be reported in the scientific literature so far. Interestingly, the woman with palmigrade locomotion rejected every device to help her move around. A similar psychomotor approach was previously reported in four cases, but with only one paralyzed leg as a post-polio sequel [2, 3]. That is, they also rejected every assistance to walk upright, strongly preferring walking on all fours (actually tripodal, palmigrade locomotion). The forward locomotion was achieved by using the hands alternately, while jerking the paralyzed leg forward during each step using the back muscles, like the present case. However, each of the previous cases had a healthy leg, while the present case had no active legs to support the body.

Any kind of palmigrade locomotion may be the result of the spontaneous neural control through the central pattern generators (CPGs) located within the spinal cord [4, 5]. However, the concept of CPGs, which formerly invoked much interest with regard to the origin of quadrupedal locomotion, is not accepted in the light of the dynamical systems theory. Accordingly, Cohen [6] argued that: "it is not possible to speak of the command neurons driving the CPG since they are both driving each other. As a consequence of the mutual interactions within the system, each portion of the system contributes its own peculiar properties and constraints to the final output." Moreover, Thelen and Smith [7] also reported that "the notion of the CPGs as the essence of locomotion does not fit the data... They simply do not account for what we really observe in developing organisms." So the role of the CPGs in the emergence of palmigrade locomotion can be excluded [see also 8].

Interestingly, despite their similarities with respect to post-polio impairments, entirely different styles of locomotion emerged in the affected man and woman. So, whatever the pathological conditions may be, we have here two different dynamical systems involved in two different persons. Apparently, the man's dynamical system could not create an adaptive solution for a locomotor constraint, while the woman's responded to the physical constraints with the creation of a palmigrade locomotion. In other words, the man could not overcome the infantile sitting stage and remained without locomotion, while the woman developed a transition from the infantile sitting stage to walking on two hands. This means two different attractor states emerged following two similar neural constraints, and this provides evidence for a spontaneously and randomly occurring adaptive self-organization, as a holistic process which occurs in dynamical systems with very large numbers of interconnected elements, without previously established neural and/or genetic code or any other motor program [7, 9, 10, 11].

In light of the above considerations, the emergence of a motor behavior such as bipedal, quadrupedal, tripodal, or palmigrade locomotions may be the result of dynamic interaction of many elements such as genetic, neural (e.g., CPGs), joint flexibility, postural constraints, balance, body constraints, muscle strength, extensors and flexors, perceptual processes, cognition, motivation, environment, hormones, and so on. Therefore, the output of the developing locomotor system may result in unpredictable behavioral attractors, including the reappearance of atavistic traits, such as the whole spectrum of palmigrade locomotion styles in human beings, suggesting a reverse evolution in humans, first reported by Tan [3, 12, 13, 14]. The reverse evolution and even the evolution itself may also be considered as an adaptive self-organization process [15]. The two cases presented in the current work may provide evidence for the spontaneously (i.e. randomly and unpredictably) occurring adaptive self-organizing processes. The emergence of two different attractor states in two neurologically similar cases is consistent with the random nature of the self-organizing dynamical systems. In other words, two different persons with similar neurological disturbance, but different brains, bodily and environmental constraints, and consequently different adaptive self-organization processes, may create different attractors to solve the problem of the similar neurological constraints.

Another interesting difference between the two cases presented in this work was the existence of a strong and enduring palmomental reflex in the woman, but not in the man, who did not have a visible palmomental reflex. This is a primitive reflex that can be elicited by stroking the thenar eminence of the hand, causing contraction of the mentalis muscle in the chin [16]. Although this reflex may be present in normal humans (11%), its strength, repeatability and persistence without habituation may indicate a suprasegmentary lesion [17, 18]. The co-occurrence of two primitive events only in the woman and not in the man— the primitive palmomental reflex and the primitive palmigrade locomotion — is consistent with the theory of reverse evolution in human beings.
Conclusion

Conclusions
We presented here two new cases of post-polio paraplegia. Each individual had two paralyzed legs as the result of infantile poliomyelitis, but their mode of locomotion was different: the man failed to move at all and relied on a wheelchair to get around, while the woman developed a palmigrade style of locomotion in childhood and preferred this style of locomotion to walking upright with the assistance of crutches, or moving around in a wheelchair.

Both individuals were bright and appeared otherwise normal. It was suggested the development of two styles of locomotion may provide evidence for their being a result of the random and unpredictable adaptive self-organizing processes. The two cases had the same physiological constraints and similar neurological disturbance, but different adaptive self-organization processes created dissimilar solutions to their locomotion problems.

The woman (but not the man) exhibited the primitive palmomental reflex. It was suggested that the simultaneous occurrence of the primitive style of locomotion and the primitive reflex are consistent with reverse evolution in humans.

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Authors contribution(s)
The corresponding author designed and completed this study, visited and filmed the cases, helped in MRI and neurological examinations, along with the interpretation of the results, and consequent writing of the manuscript.

References

1. Muybridge E. Human Figure in Motion. London: Chapman & Hall, Ltd.
Illustrations

Illustration 1

Diagonal-sequence quadrupedal locomotion in the child with a paralyzed leg (Muybridge, 1901)

Illustration 2

Successive photographs of the paralytic child taken by Muybridge (1901)
Illustration 3

Paralytic child walking on all fours from Muybridge (1901) painted by Francis Bacon (1961)

Illustration 4

Konya family with mother (hand-walker), man, and three children
Illustration 5

MRI scans: A,B: sagittal; C,D. coronal; A,C: woman; B,D: man
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