

Origins of Obligate Bipedalism in Hominins: An exploration of timing, theoretical reasoning and response.

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The path hominins took to become obligate bipeds remains controversial in several respects. The purpose for becoming bipedal, the evolution of bipedal gaits, and the consequences of being an obligate biped have been thoroughly explored theoretically. However, applying these theories to the archaeological record remains difficult due to sparse fossil remains over this critical transformation in hominin evolution. Harcourt-Smith and Aiello (2004), note the three major areas of concern pertaining to hominin bipedalism: 1) the locomotor repertoire that preceded bipedalism, 2) theoretical debate over reasons for becoming bipedal and 3) the degree in which certain hominin taxa were obligate bipeds. This paper addresses each of these issues, beginning with the precursor

to bipedalism, followed by an overview of the hominin record and the degree to which individual species may have been bipedal, and lastly discuss the theoretical reasons for becoming a biped and its resulting consequences. We will evaluate how bipedalism arose as the most efficient form for carrying loads and long distance transportation, and how this is seen in the traits that were selected for in order to achieve bipedality. These traits are related to the current archaeological evidence we currently have, the known behavior of closely related apes, and speculation on what can be assumed about hominin evolution despite lacking direct archaeological evidence.

Precursor to Bipedality:

Trying to determine a given species that can be dubbed the precursor to bipedal hominins is likely impossible. A large chunk of time remains where hominins are hotly debated to be obligate or simply facultative bipeds; a debate that will be discussed in detail later. However, for the true precursor to bipedalism, we must look beyond the common ancestor of humans and chimps (as both are bipedal to some degree), and instead look at the common ancestor shared with great apes. It can be argued that with this common ancestor lies the key to the bipedal precursor (Harcourt-Smith and Aiello 2004).

There has been great debate as to whether the last common ancestor with apes was a knuckle walking ancestor (Richmond et al 2001) or a climbing ancestor. This climbing ancestor is argued to be either a small-bodied climber or arboreal biped with no significant terrestrial locomotion (Tuttle 1981, Harcourt-Smith and Aiello 2004) or a larger-bodied ancestor who used all four limbs to grasp supports during vertical climbing

and suspension (Hunt, 1996). The knuckle-walking ancestor is championed under the idea that *A. afarensis* has a similar wrist morphology to that of current knuckle-walking apes, although this is a variable interpretation (Harcourt-Smith and Aiello, 2004). Arguments for an arboreal ancestor rely largely on the well known fossil hominid *Proconsul*, from the Early Miocene of Kenya, which remains analyzed as a non-specialized arboreal quadruped with grasping capabilities (Nakatsukasa, 2004). *Proconsul* is thought to be the last known hominid fossil where bipedalism is not selected for, and when analyzed further could actually be used to better argue for a knuckle-walking ancestor, rather than arboreal, due to its narrow rib cage.

Regardless of which scenario is correct, it is at this transition from quadruped to facultative biped that there exists a reorganization of the innominate, allowing a more upright posture than purely quadrupedal species (Harcourt-Smith and Aiello, 2004). It is this transition that leads to obligate bipedalism as the most efficient adaptation for traveling distances. Certainly there are other gaits that remain more efficient than bipedality, however once this change in innominate takes place it would prove more 'difficult', evolutionarily speaking, to return to an efficient quadrupedal form as opposed to adapting to a bipedal gait.

Bipedalism in Early Hominins:

Determining the earliest obligate biped is a difficult task because many species are recognized by single specimens. In some cases, these are cranial elements giving us little to no insight on their gait. Others may be singular postcranial elements from which we can then extrapolate the 'most likely' full form based on modern humans and other

specimens. The ideal situation is when a foot bone is found. Yet, again, from this singular bone the morphology of the entire foot is derived.

The most well known model for early human foot evolution was proposed by Morton (1935). He argued that the early human foot would be more similar to that of *Gorilla* as opposed to *Pan*, simply because gorillas are more terrestrial based. While this is true, he failed to note that both gorillas and *Pan* have been under selective evolutionary pressure in their own right, and thus may be highly derived from any common ancestor as well. It seems more likely that the similarities that occur between the two are derived independently. It would also be possible, if one assumed a knuckle-walking ancestor, for this model to be theoretically correct in which case *Pan* would be said to have undergone selective pressure to deviate from this more terrestrial based foot morphology that would be present in its lineage as well. Regardless, this theory was developed based purely on modern comparatives and no archaeological evidence (Harcourt-Smith and Aiello, 2004). Other avenues can explain the similarities between hominins and gorillas.

Two more models of foot evolution have since been proposed. Lewis (1989) proposed a model showing that transformation of an ape like foot to a modern human foot via the great toe being abducted in line with the other toes. He argues that this loss of an opposable toe is the first step to creating a modern foot, and that due to the instability this shift creates, the rest of the foot and associated joints adapted as necessary. The second model is proposed by Kidd (1999), who argues that it is the lateral side of the foot that adapted first, allowing retention of the opposable toe until very late in the process. However, Kidd only examined a singular specimen, OH8 a *H. habilis* foot, which we will see is arguably not an 'early' occurrence of bipedality. These models will remain

debatable and highly theoretical until further specimens are recovered and until then, the argument about which species are indeed obligate bipeds remains.

The earliest hominin specimens found consist of few skeletal elements. It is from these few elements that evidence for bipedalism is offered. It is argued that the first appearance of bipedalism is seen in *Sahelanthropus tchadensis* dating 6-7Ma. This specimen consists only of a cranium. The argument for habitual bipedality is based on the skull's "basicranial and facial similarities to later fossil hominids that were clearly bipedal" (Brunet et al. 2002). *Orrorin tugenensis*, which is dated via the surrounding sediments to 6Ma, is believed to be bipedal based on a 'terrestrial adapted' femur, while its humerus and manual phalanx show arboreal adaptations (Senut, 2001). While the evidence for bipedalism is apparent, one could question the dating in this case. Finally, *Ardipithecus ramidus kadabba*, dated to 5.2Ma, is said to be terrestrial bipedal based on the morphology of a foot phalanx which shows similar characteristics to *A. afarensis* (Halle-Selassie, 2001). Therefore, it is assumed that habitual bipedality has been established in hominins by 5.2Ma and possibly as early as 7Ma.

Defining the point of obligate bipedalism proves more difficult. It is debatable whether bipedalism arose in one form or whether there were several adaptive variations, making a discovery of a linear evolution impossible. The problem also lies in the lack of clear relations of early hominins. The archaeological record remains sparse and often a species is based on a singular specimen that consists of a singular bone fragment, so to derive relations in a highly variable group of hominins and then attempt to create a linear evolution of a single trait is daunting to say the least. The best way to approach the task is

looking at the individual species. The temporal distribution of known hominin taxa is shown in Figure 1, along with the species thought to be habitually bipedal or obligates.

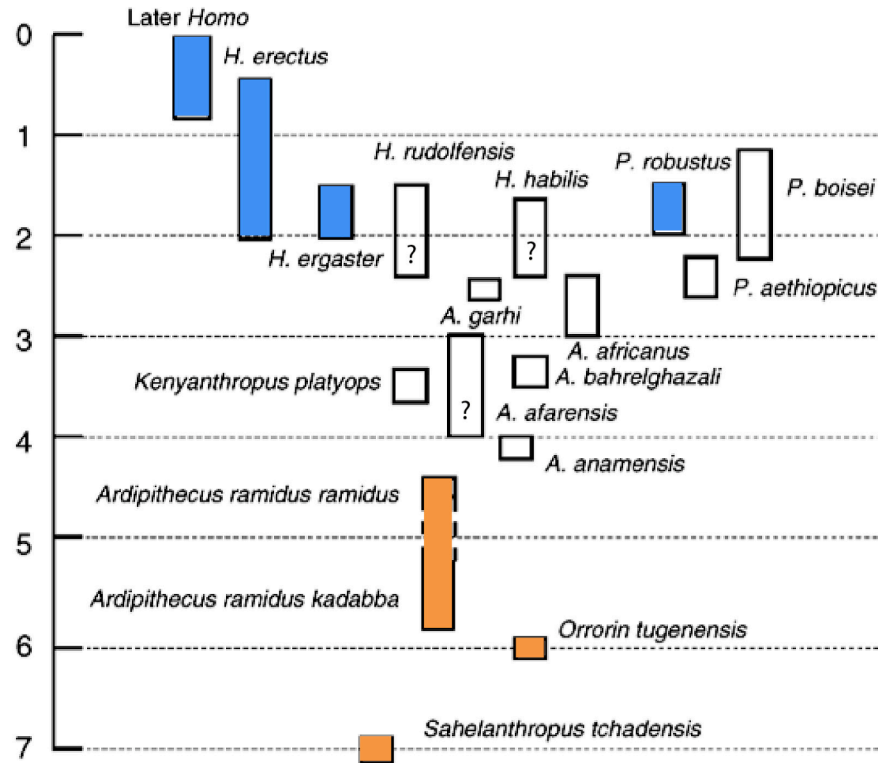


Fig. 1 The temporal distribution of known hominin taxa.

Adapted from Harcourt-Smith and Aiello, 2004
 Orange: known habitual bipeds, Blue: known obligate bipeds

As noted earlier, *Sahelanthropus tchadensis*, *Orrorin tugenensis* and *Ardipithecus ramidus kadabba* all have arboreal traits as well as those associated with habitual bipeds and can therefore be assumed to be habitual bipeds themselves. It can also be said that *H. ergaster*, *H. erectus* and all later *Homo* are obligate bipeds. This is based on a relatively complete understanding of these species morphology due to more fossil specimens.

While it can still be debated due to their range and behavior, we can assume that *Paranthropus* was also an obligate biped. It is important to note that while for *P. robustus*

this is almost certainly true, early postcranial elements of *P. boisei* are debatably *H. habilis* (Wood and Constantino, 2007).

The posture and gait of *H. habilis*, *H. rudolfensis* and *A. afarensis* are also debatable. *A. afarensis*, best known by the partial skeleton 'Lucy', AI 299-1, dated to 3.2Ma, shows clearly derived bipedal adaptations. These include a more human-like pelvis and wide sacrum, and human-like bicondylar angle of the femurs (Stern and Susman, 1983). However, there are several postcranial ape like features still retained such as cranially oriented glenoid and long, curved pedal and manual phalanges (Harcourt-Smith and Aiello, 2004). Thus, it is concluded by most that *A. afarensis* was a habitual biped at the least. The question is then how important the retention of their arboreal traits was in their locomotion. Were these traits retained as a necessity (proving them to be habitual bipeds) or were they simply retained due to the fact that their morphology had not been completely transformed for obligate bipedalism yet, even if their behavior was thus? Ward (2002), attempts to answer this very question, and concludes that while it appears that these arboreal traits are retained because they are selected for, no definitive conclusion can be met. Even still, Latimer (1999) suggests that *A. afarensis* was an obligate biped primarily on the grounds that they lack relatively long fingers and toes and a grasping foot which is essential for efficient arboreal locomotion, noting that selection against efficient arboreal locomotion is evidence for selection for efficient terrestrial locomotion. However, the act of selecting for more efficient terrestrial locomotion does not signify that one has abandoned arboreal utilization. Thus, we will call *A. afarensis* a habitual biped until evidence suggests otherwise.

H. habilis is perhaps the most controversial species. It is often associated with other divergent species and debated to belong to *Homo* or *Paranthropus*. *H. rudolfensis* is also arguably placed within this taxa (Lieberman et al 1996). *H. habilis* is either a taxa with extreme variability, or the representative of a group of several species with not enough archaeological clarity to determine exact relationships. Debate about being obligate bipeds is similarly confusing. There seems to be a large amount of postcranial variability that is argued both for and against obligate bipedality (Wood, 1987). It is also noted through this species that there may be evidence for several derivations or adaptations to bipedalism, leading to varying foot morphologies (Harcourt-Smith and Aiello, 2004). With little clarity, it is at least known that this taxon was at least habitual bipeds, and until further delineations of species are made, the question of obligate bipedalism remains.

Despite the great debate over the nature of *H. habilis* and *A. afarensis*, it is shown that obligate bipedality was acquired between 2-4Ma; the earliest possible obligate being *A. afarensis* and the latest possible being around the time of *H. ergaster* (Figure 1).

Traits selected for:

One can assume that if we are able to discover the attributes that were selected for during the transition from habitual to obligate biped, the reasons for the transition should become apparent. In order to evaluate what these attributes are, we can compare two well known species, one which is thought to be an obligate biped, *H. ergaster*, and one which is thought to be a habitual biped, or at an early form of obligate biped, *A. afarensis*. These two species are very well known thanks to ‘Lucy’ (*A. afarensis*, AL 288-1) and the

Nariokotome skeleton, or Lake Turkana boy (*H. ergaster*, KNM-WT 15000). Through the comparison of these two specimens, and experimentation done on morphological recreations by Wang and Crompton (2004), we should be able to determine the situations in which *H. ergaster* is more efficient and adapted than the earlier *A. afarensis*.

Morphologically, *A. afarensis* is very different from modern humans. *A. afarensis* consisted of a long trunk and short limbs. They retain evidence of grasping toes and funnel-shaped thorax but introduce a permanently abducted posture of the knees that is very ‘human-like’ (Wang and Crompton, 2004). *A. afarensis* is thought to have moved with a “bent-hip, bent-knee” (BHBK) gait, which was originally argued to be useful only in ‘postural’ bipedalism, as seen in chimpanzees for feeding. It is also assumed that this taxon would move with a shuffle, and thus be less efficient than a full stride (Wood, 1994). However, it is argued that the more human like arrangement of the knees would counter-act some loss in efficiency and better allow sustained bipedalism (Wang and Crompton, 2004). It is noted that *A. afarensis* “short legs and long and funnel-shaped trunk favour static stability, and short legs may permit rapid changes of direction and rapid acceleration of short distances” (Wang and Crompton, 2004). This is suggested to be favorable in woodland environments, which have been argued to be the environment in which *A. afarensis* evolved.

H. ergaster has longer limbs and a shorter and more barrel shaped trunk. This species is considered nearly ‘modern’ in postcranial morphology and there seems to be no argument over its existence as an obligate biped. They are considered to have a modern gait with a long stride.

Wang et al (2004) and Wang and Crompton (2004), ran a series of biomechanical tests based on the known constraints of these two specimens to test the efficiency of their gaits free of stressors, efficiency when carrying loads, and the hypothetical musculature efficiency. These were then compared to each other (Wang and Crompton, 2004), and to modern humans (Wang et al, 2004).

Wang et al (2004) focused on estimating the required muscle power needed for bipedal walking for *H. ergaster* and *A. afarensis* gaits and compared them with those of modern humans. The models were run with both erect and BHBK gaits. They concluded that if one were to evaluate based on the expenditure of power per unit mass (W/kg), both *A. afarensis* and *H. ergaster* would require similar power to that of modern humans. However, if distance were considered, *A. afarensis* would require the expenditure of relatively more muscle power (W/kgm^{-1}) compared to modern humans. This suggests that the body proportions for *H. ergaster* and modern humans may have evolved for efficiency of bipedal walking over long distances and/or at higher speeds (Wang et al 2004).

Wang and Crompton (2004) created three-dimensional models of *A. afarensis*, and *H. ergaster*, then ran segment kinematic tests comparing the results to modern humans. Both taxa were shown to be able to sustain stable erect walking suggesting the possibility for *A. afarensis* to be an obligate biped. During these tests, the *A. afarensis* model was run with both an erect posture and the supposed BHBK gait. All testing was run on a simple horizontal plane. The same tests were run, with the addition of loads of different weights (between 0-30% of body weight) to compare the changes in efficiency when moving with a load.

The tests show that *H. ergaster* erect posture walking required half of the physiologic cost that BHBK walking by unloaded *A. afarensis*, and the body core temperature raised only half the amount of *A. afarensis* when traveling the same distance. There is also a 40% decrease in mechanical energy costs for the *H. ergaster* gait from the *A. afarensis* gait. This relationship was significantly amplified when loads were applied. The BHBK gait became increasingly ineffective with an increase in percent weight load. When comparing the *H. ergaster* model with modern human gait, the modern human gait is shown to be more efficient in both distance and load bearing, but not to the extreme that exists between BHBK and erect posture in *H. ergaster*.

From Ward et al (2004), and Ward and Crompton (2004), the selectivity for traveling further distances and becoming efficient in load carrying are shown. If these two factors were indeed the selective pressure for developing into obligate bipeds, it gives a lot of insight to this transitional period. This transition could mark an ecological shift from partially closed environments where *A. afarensis* would be efficient with short and often lateral movements, to a more open habitat where an endurance based gait would be more beneficial as seen in *H. ergaster*. The ability to go the distance could then aid in acquiring a higher quality diet, allowing an increase in size (Ward and Crompton, 2004). Regardless, these experimentations show two things occurring in the evolution of bipedalism: 1) traveling greater distances becomes more effective and 2) carrying loads becomes more effective.

Theoretical reasons for becoming bipedal:

The theoretical reasons why one would become bipedal have a long history of varying arguments. They range from the somewhat outlandish argument such as the ‘Aquatic Ape Theory’, where floods caused a terrestrial bound early hominid to gain an erect posture to essentially wade through life, to more plausible theories such as the need to see over the savannas. While the theory of seeing over tall grass once early hominins have moved to the savanna sounds more plausible, it is not likely since early bipeds (*A. afarensis* for example) were still in partially wooded habitats. Why then would one adapt in such a manner? Here we will discuss three of the different theories, and by no means the only theories, that are currently debated: scavenging, tool use, and infant care.

The argument for scavenging is best noted when comparing early hominins to modern Japanese macaques and Tufted Capuchins (*Cebus apella*). Macaques can be trained in traditional bipedal performance, and show an ability to walk more efficiently than ordinary untrained macaques (Nakatsukasa, 2004). Hewes (1964) notes the presence of a troop of macaques that when faced with an over abundance of food, would adopt a bipedal stance to acquire the food and transport it to a safer location. In this example, the locomotor habit emerged as part of a chain of new behavior initiated with this change in food supply. This behavior is similar to what one would expect when adopting a scavenging lifestyle as well. As a scavenger, one would opportunistically utilize a bipedal stance to carry the large amounts of food acquired spontaneously, and attempt to transport it to a safer location, avoiding other scavengers. A similar phenomenon was seen with tufted capuchins, where a bipedal stance was more readily adapted with the acquisition of bulky foods as opposed to smaller massed foods (Westergaard et al, 1999). Thus, the argument states that the shift to a scavenger lifestyle for early hominids

selected for bipedalism because they were faced with large supplies of food, which then needed to be carried efficiently. While this theory satisfies the two traits that were apparently selected for, traveling distances and carrying loads, it is not the only mechanism that could explain the rise of bipedality.

Another plausible argument for bipedalism presented by Brace (2004), is tied to canine tooth reduction and obligatory tool use. The theory states that human bipedalism is slow and early bipedal hominins were relatively small. To survive on the African savannas or open woodlands it would be necessary for these early hominins to possess an unparalleled means of defense. In other species, such as gorillas, this may have been a robust canine tooth, however in early hominins there is shown to be a reduction in canine tooth size. Brace then noted an experiment previously run, where baboons employed a digging stick to assist in foraging. This nearly doubled their foraging efficiency, and could potentially be redirected as a weapon. Such a weapon/food acquisition tool would both explain the persistence of a small slow hominin on the savanna as well as a reduction in canine tooth size. The argument for bipedalism then becomes: in order to effectively protect oneself and be efficient in foraging with a pointed wooden stick, one would need to carry the pointed wooden stick with them, thus requiring the animal to assume an erect posture in which carrying the stick is easily done. While obligatory tool use may have aided in the effort to become obligate bipeds, it is unlikely this manifested in needing to carry one's pointy stick with them.

The final argument discussed here is the concern of infant altriciality. With the loss of fur and grasping capabilities, infants become more helpless and need to be transported by other means than them holding on and hitching a ride. Sokol and

Thompson (2004), discuss the available options to deal with such a loss in an infant's ability to hang on, which include being cached versus carried. The argument for caching a baby exists on the basis that it would increase foraging efficiency, and is supported by the loud cries of human infants. However, caching one's baby on the African savanna seems like a perilous endeavor. Thus, it remains more likely that as infants began to lose their grasping capabilities and mothers began to lose their fur, these infants required carrying. It is important to note that this may be both a result of bipedalism as well as a selective force. The loss of grasping capabilities is thought to have occurred simultaneously with bipedalism when the foot and hands become reorganized and specialized. Thus, while this trait may certainly encourage bipedalism, it almost certainly was not among the original stressors. However, it may have resulted in a type of positive feedback.

As noted earlier, there are many more theories besides the three discussed here. However, like the three above, they all seem to lack the ability to singularly explain obligate bipedalism. Thus, one can assume it was likely a multitude of environmental and habitat based stressors that were the cause of such a transition.

Results of Bipedalism:

Bipedality was a major transition in human evolution and can be argued as a precursor to many things that are uniquely *Homo*. Here we will discuss a few immediate theoretical benefits and concerns resulting from the modern erect gait, linking them to the archaeological record when possible.

One of the most robust benefits, which we have touched on several times so far, is the ability to travel further distances. This fact has been tested biomechanically (Wang et al, 2004, Wang and Crompton, 2004), as a trait that has been selected for in hominid bipedalism. It is also shown in the archaeological record by determining how the distances of lithic source material changes over time. The distance traveled for source material shows a steady increase, from 2km range in Bed I to 14km and more in Bed II (Close, 2008). It is still debatable as to which species these tools are attributed to, and is argued that the former may be *H. habilis* or *A. afarensis* where the later may be *H. habilis* or *H. ergaster*. Regardless, this presents direct archaeological evidence of an increase in range for lithic sourcing.

This increase in range may also have an effect on one's ability to become a successful scavenger, which in turn could also be a selective stressor for efficient carrying, perhaps creating another positive feedback relationship. To be a successful scavenger with the least amount of competition, one must either be an early scavenger with the ability to protect the food source from other scavengers by either defense or movement/caching, or be a late scavenger with the ability to utilize low return resources. The key to scavenging is to acquire found food without getting yourself killed by other competition that may find that food as well. The ability to carry efficiently and for long distances would certainly benefit an early or opportunistic scavenger.

Even more so, adapting a nomadic lifestyle would prove valuable. Assuming a scavenger is in competition with top predators, who will also scavenge opportunistically if the meat presents itself, by becoming nomadic and moving between different predator's territories, one becomes less likely to conflict with said predator. By

minimizing the time spent within a single territory, an early hominin may reduce its likelihood of becoming a primary target for consumption. Endurance walking and constant movement also increases the chances of encountering a 'natural death food source', in which an animal has died for reasons other than being hunted by some predator and is still a viable source of meat. Since most animals die due to something other than being hunted, this is likely a critical portion of a scavengers diet. (Close, 2008) Thus, efficient endurance walking and load carrying very well could be attributed to a scavenging past.

Another consequence of becoming an obligate biped is the freedom to use one's hands. As the foot becomes specialized for endurance walking, the hands are now free to specialize as well. This would theoretically lead to a multitude of things. Primarily, it would allow the hands to make and utilize tools. While this is easily done by habitual bipeds (Panger et al, 2002), the dexterity of the hand for this purpose is limited due to the necessity to retain certain features for arboreal lifestyle, terrestrial support or both. Without the need to retain such features, the hand can reorganize and the ability to have fine-tuned muscle movements leading to precision tool making is realized. This can be seen in the archaeological record with the development of Oldowan stone tools associated early on with arguably habitual bipeds (Semaw et al, 2003), and the transformation through time with increasingly specific tool technology. Without the specialization of the hand, a direct result of obligate bipedalism, this evolution in tool technology may not have occurred.

Along with the specialization of the foot and the hand, one begins to lose their grasping capabilities. As noted earlier, in possible causes for bipedalism, early hominin

infants become increasingly helpless due to the fact that they can no longer hang on to their parent as seen in our close relatives, chimps and bonobos. Also noted earlier, this trait likely developed simultaneously with bipedalism for the very reason that this is when one would lose their grasping capability. The timing of fur loss is debatable, but seems to have evolved simultaneously with the development of longer bodies for heat dissipation by 1.6Ma (Brace, 2004). Regardless, fur without the ability to hang on to it is still not helpful. So, the discussion returns to what early hominins did with their babies.

As discussed earlier, it is not likely that one would cache or park their baby in the African savanna. It is more likely infants would be carried, particularly with the notion that early hominins ranged over far distances. Another option is presented, that infants are crèched, or kept in large groups watched by a few adults or juveniles (Sokol and Thompson, 2004). Essentially, they are babysat. This is then used to explain why modern human infants have such a loud cry. The argument is that if an infant was constantly carried, why would it possess such a loud cry? (Sokol and Thompson, 2004) However, if infants were kept in close proximity to an adult, why a loud cry is needed is still unexplained.

This is not the only theory relating vocalization to bipedalism. It is argued that by becoming bipedal, the acts of breathing and locomotion have become uncoupled which sets the groundwork for human language (Provine, 2004). Provine notes a critical distinction between humans and chimpanzees. While chimpanzees are able to understand human language, they are incapable of producing it. To determine the reason, he focuses on the difference between human laughing and chimpanzee laughing. A human laugh consists of several sounds being created in a singular outward breath. Chimpanzee

laughing consists of a single sound per single breath repeated. This is because the chimpanzee has the inability to separate its sounds from its individual breaths. Humans have the ability to do so, which then allows the creation of different sounds allowing the creation of a formal language. This, argues Provine, is due to the erect bipedal gait.

Another argument for language development relies on the parking of an infant. Thus, vocalization is needed in order to communicate while foraging with your infant nearby. Since the idea of parking the baby is still not plausible, I would say that this theory of language evolution is not plausible as well.

What can we assume is coupled with bipedality?

What can we assume, if anything, about early bipedal hominins that cannot be seen in the archaeological record? Discussing the transition to obligate bipeds is a difficult task because it is based on theoretical assumptions, which then makes it more difficult to create further assumptions about early hominins based on this 'evidence'. However, while traits not appearing in the archaeological record cannot be assumed to have existed without substantial alternative evidence, speculation can be made about what might have occurred during such a transition.

Loss of mammalian body fur, as mentioned above, most likely occurred by 1.6Ma. This is not evident in the archaeological record, however looking at the body proportions of KNM-WT 15000, *H. ergaster* specimen, it appears that the longer limbs and shorter trunk were utilized for heat dissipation (Brace, 2004). Similarly, the bipedal gait appears to have been selected for an efficient form that significantly reduces the increase of internal body temperatures with work (Wang and Crompton, 2004). These

traits suggest the stress of heat, and under the stress of heat, a mammalian fur coat would be the first trait to diminish.

It seems an impossible task to pinpoint the origin of human language; however, with the ability to separate locomotion and breathing, a trait acquired with erect bipedal gait (Provine, 2004), allows the determination of a relative time frame. It can be assumed that early hominins did not have a complex language system before this transition. The degree to which language developed throughout this early period is likely to remain unknown.

The necessity to carry appears to be an important aspect of both the evolution of bipedalism and the resulting lifestyle. The discussion of early hominins possessing bags or slings to aid in their carrying is a controversial one. Rosenberg et al (2004), notes the importance of slings with helpless infants. Once again, it is not likely to park your baby on the savannah, however if one is required to carry an infant with their arms at all times, this would greatly reduce foraging productivity. It seems more likely that one would develop a system to attach their infant to themselves. This is not a difficult task, and one that could easily be accomplished by an individual with the ability to utilize stone tools.

The argument for bags is also made for carrying tools and source rocks (Falk, 2004). With an increase in range, early hominins begin to transport more material over further distances. It is shown to be much more efficient to carry excess weight against the body as opposed to in one's arms or hands (Wang and Crompton, 2004). Thus, it seems likely that lithic material and/or tools were carried in a similar manner. While these slings or bags would be made out of plant material or pelt, it remains highly unlikely that evidence for such contraptions will be uncovered for this time period. However, the

technology is simple and efficient, and should not be considered beyond the abilities of early hominins.

Conclusion:

The evolution of obligate bipedality was not a rapid transition. There were most likely several variable adaptations to acquiring the trait. We have discussed the possible precursors to early hominins, although the archaeological record is currently severely lacking in this respect. Through the analysis of two well-known specimens, AL 288-1 and KNM-WT 15000, we were able to note the key traits that were emphasized through the evolution of an obligate biped. Hominins are clearly built for endurance walking and carrying loads efficiently.

Many arguments for the theoretical reasons to become a biped and the consequences of becoming a biped are similar, and therefore most likely represent a positive feedback relationship. This is seen clearly in the analysis of infant atriciality as well as hand specialization. Thus, there appear to be many reasons for initially becoming an obligate biped, and many more reasons for an erect gait to be continually selected for.

Understanding when obligate bipedalism arose is important in understanding hominin evolution. Bipedality is a hallmark feature of hominins, and this trait was the catalyst for many other hallmark features such as precision tool use and possibly language. By understanding the timing of the rise of bipedalism, other aspects of early hominins can be inferred, such as bag use and language acquisition. All of these traits give us a better understanding of the origin of modern humans.

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