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HOW TO CITE:
Pettitt P. Did *Homo naledi* dispose of their dead in the Rising Star Cave system? S Afr J Sci. 2022;118(11/12), Art. #15140. https://doi.org/10.17159/sajs.2022/15140

ARTICLE INCLUDES:
☐ Peer review
☐ Supplementary material

KEYWORDS:
burial, funerary caching, caves, *Homo naledi*, taphonomy

PUBLISHED:
30 November 2022

Did *Homo naledi* dispose of their dead in the Rising Star Cave system?

Significance:

Human treatment of the dead is one of the most visible and important aspects of our behavioural evolution. Until recently, the deliberate movement of corpses to specific places in the landscape and their deposition there was thought to emerge very late in human evolution, perhaps with the advent of burial by *Homo sapiens* and the Neanderthals. The remains of *Homo naledi* in South Africa's Rising Star Cave system potentially revolutionalises that belief: did a small-bodied, small-brained hominin drag parts of corpses into the depths of the cave, and if so, what does this reveal about their cognition? How convincing is the case?

The remarkable discovery of the remains of at least 15 individuals of the small-bodied and small-brained hominin *Homo naledi* in the Cradle of Humankind's Rising Star Cave system adds significantly to a growing picture of the speciose and complex nature of evolution even within the later genus *Homo.* And in a world in which genetics have revealed a large part of this complexity, the discovery is a welcome reminder that palaeoanthropology is still predicated on exploration and the excavation of physical materials. As ever, the Cradle of Humankind provides evidence of the primacy of Africa for hominin evolution, and in particular the importance of the southern parts of the continent in that story. While the rich *Homo naledi* hypodigm offers much for the study of anatomical and biological evolution, I shall restrict my comments to the hypothesis that the remains were introduced into the cave as a form of 'deliberate body disposal' rather than by any natural agent of accumulation, as considered by Dirks et al.[1] The Rising Star team have been balanced in their consideration of competing hypotheses for the introduction of the *Homo naledi* material into the cave, including an initial consideration of funerary caching given that there was a lack of any animal remains other than microfauna, a partial juvenile baboon and partial owl in a cave yielding >1500 remains of *Homo naledi*, in addition to the lack of clear indicators of natural causes of the accumulations such as transport by water, catastrophe or carnivore.

It remains possible that the Rising Star Cave represents an early expression of funerary activity by the genus *Homo.* As it stands, I am broadly in support of the team's working conclusions in this light, and although I will suggest that there are one or two factors that still need to be elucidated, I want to consider issues relating to the debate, particularly to our paradigmatic biases and how they influence our reception of the funerary caching hypothesis, before considering the argument as it stands today in the light of the cave system and the hominin material.

Paradigmatic reservations: Is funerary caching plausible?

While a barn owl and a baboon may have got lost in the cave, and died there[2], it has been difficult to identify a 'natural' cause such as this for the deposition of the *Homo naledi* remains in and around the Dinaledi sub-system. Although Dirks et al.[1] acknowledged that 'mass mortality of groups of hominins within the Dinaledi Chamber, due to a death-trap scenario, is possible', this was clearly not a singular event; why would at least 15 individuals continue to explore the depths of a cave, only to get lost and die, repeatedly over a period of time? If, by contrast, it can be demonstrated that this reflects deliberate behaviour, it has potential implications for our understanding of human cognitive and behavioural evolution. No surprise, then, that the issue has been subject to debate. One of the several hypotheses the Rising Star team consider is that bodies – or parts of them – were deposited deliberately as a form of mortuary activity – 'funerary caching' as I named it[3]. But as Randolph-Quinney[4] noted, this notion that a small-brained and relatively primitive hominin could repeatedly dispose of the dead in a deep cave 'is bound to meet with resistance'. One assumption we have all made is that if the body parts were deliberately placed in the cave, then the agent responsible for this was *Homo naledi,* rather than another, perhaps larger-brained hominin. Leaving that speculation aside, Dirks et al.[1(p.152)] ask, 'should we be surprised at the idea of a small-brained hominin species caching bodies in an inaccessible place?'. My answer to this is resoundingly no – we shouldn't. I have no objection to the notion per se: while the transport of bodies deep into a cave system required a 'non-trivial expenditure of effort', I see no reason why the exploration of an underground system by a small-brained human species should require a 'surprisingly high degree of knowledge' that needed to be 'passed on from generation to generation' as one critic suggested.[5(p.146)] As Dirks et al.[1] noted, non-hominin primates exhibit considerable variability in their reactions to and treatment of the corpses of their conspecifics and a glance beyond the primate world reveals complexity in mortuary behaviour widely in the animal world[6]. As methodologies for investigating primate behaviour towards the dead emerge[7], we may well lose our surprise that funerary caching in the genus *Homo* occurred, from time to time, among several taxa.

From the 1980s, hominin funerary behaviour – at least burial – has been set up reverentially on the altar of cognitive and behavioural modernity, worshipped as a sacred trait on the checklist of 'behavioural modernity' and monotheistically assigned, like art, exclusively to *Homo sapiens.* I suspect this has made palaeoanthropologists averse to the notion that 'pre-modern' humans had funerary practices, as many are to the notion that Neanderthals created art. True, hypotheses need testing, but an incorrect and *Homo*-centric paradigm that exaggerates the cognitive sophistication of dealing physically with dead conspecifics is of little help. Termites remove their dead from nests and cover them with sediments, and although such caching and burial behaviours (as a palaeoanthropologist might refer to them) are chemically induced and relate to homeostasis, the practice reveals that such behaviour is far from exceptional. Critics of the notion forget that bodies may be deposited in deep caves without any sophisticated cognitive rationale behind the behaviour: the problem perhaps should be seen not so much as recognising the act of curation and deposition of the corpses of conspecifics in a specific place, but how to identify

the origin of complex ideas which eventually came to be associated with such behaviour. Let's forget the latter for now.

How do we know what funerary – at present, in fact, any – behaviour *Homo naledi* was capable of? The available endocast from the Dinaledi Chamber has been taken to suggest that the taxon shared the ability for 'serialised communication, planning, and complex action', an 'increased display of prosocial emotions' and the possession of mental 'sequences that underlie tool production' that distinguished the genus *Homo* from the australopithecines. This is despite the retention of a brain intermediate in size between *Australopithecus sediba* and *Homo erectus*.[8] If this is the case, then perhaps in the case of early funerary behaviour it was not brain size that counted. One thing that such a practice would require is light. Why has no evidence of artificial light (in the form of charcoal fragments in Units 2 or 3, or torch wipes on the cave's walls) been recovered? Despite the evidence of post-depositional reworking, one might expect fragments of charcoal to remain in Unit 3 at least. Might any of the stalactites contain evidence of soot?

We need to be open to honest considerations of such hypotheses, at least when natural causes can be ruled out. But to what extent can these natural causes be excluded?

Was there another opening at the time of deposition of the hominin remains?

The Rising Star Cave system inclines downwards from the current entrance an average of 17° and the Dinaledi Chamber is 30 m underground and 80 m in a straight line from the current opening, at least 10 m below the level of the cave's palaeo-water table.[9] The 'extremely numerous and concentrated' *Homo naledi* remains in the Chamber derive from 'largely unconsolidated mud-rich sediments deep inside the cave away from any obvious cave opening which suggests that a special confluence of circumstances contributed to their accumulation'[9(p.3-4)]. These circumstances certainly included 'several cycles of sediment-flowstone fill and removal/dissolution as the level of the water table in the cave changed repeatedly'[9(p.4)]. Angular mud clasts interpreted as reflecting 'minimal transport and low-energy processes in the cave chamber' accumulated as a debris cone that 'largely developed in the *absence of either sustained flowing or standing water*'[9(p.6)] (my emphasis) and (in the case of Unit 2, which contained several fragmentary hominin remains) which 'gradually slumped into the Dinaledi Chamber'[9(p.11)]. The overlying Unit 3, which contains the bulk of the hominin material, derives from the reworking of Unit 2 mud clasts into a brown muddy matrix which accumulated across the chamber and penetrated some but not all side passages[9(p.12)]. Mineralogical comparison of the Unit 2 and 3 sediments with those of the upslope 'Dragon's Back' Chamber – through which on current evidence the material would have had to move if it did derive from downslope movement – reveals that, while the deposits of the Dragon's Back Chamber are consistent with deriving from downslope movement of allochthonous material, the Dinaledi Chamber 'was an isolated sedimentary environment at the time of deposition of Unit 3, with *no or very limited transfer of sediment between the two chambers*'[9(p.14)] (my emphasis). The weathering states of the bones are uniform and 'are consistent with the effects of sub-aerial and sub-surface processes in a *periodically wet or water-saturated* dark depositional environment that experienced stable temperatures[9](p.22) (my emphasis). Despite this, the sediments of the Dinaledi Chamber are seen as having been formed in relatively dry autochthonous conditions, apparently eliminating fluvial transport as the cause of deposition and hence it is 'highly unlikely that the fossils were washed into the cave'[10].

While 'the Dinaledi Chamber was an isolated sedimentary environment'[1(p.150)], isolated at least from the upslope Dragon's Back Chamber, the question remains as to whether another entrance, now sealed, was responsible for the introduction of sediments and hominin remains, as Val[5] hypothesised. The lack of smoothing, rounding, abrasions and impact marks on the hominin remains may 'preclude transportation by water as a major taphonomic factor associated with the delivery of skeletal elements into, or within the cave system'[1(p.23)], but can one confidently eliminate seasonal, periodic *low-energy* water transport as responsible, akin to the 'creep towards floor drains…[which] removed sediment from the chamber and caused fossils to move' in the Dinaledi Chamber[1(p.150)]? It is otherwise difficult to explain the 'high-degree of bone breakage and fragmentation' of the hominin material through 'post-depositional sediment movement within the chamber as Units 2 and 3 are reworked'[1(p.23)]. If this explains the post-depositional movement and weathering of hominin remains *within* the Dinaledi Chamber, it could explain their *introduction into* the chamber from without. Dirks et al.[1(p.150)] suggest that it would be odd if such an external link existed but that the remains of other animals were not introduced into the cave in a way similar to the hominins. Was another route into the Dinaledi Chamber once open? The wider exploration and survey of the system by Elliott et al.[11] reveals a complex picture which renders this a possibility.

This question was not addressed in an earlier publication of laser scanning and photogrammetric recording of the entire Dinaledi Chamber.[12] What emerged from that was a somewhat different vertical relationship between the Dinaledi and Dragon's Back Chambers than previously published schematic sections suggested, wherein the former is directly below the latter, rather than aside it and linked only by The Chute at ceiling level in the Dragon's Back[12] (see their Figure 3). The subsequent exploration of the wider system[11] significantly expanded the known extent of the interlinked passages and chambers, revealing other routes of possible ingress into the Dinaledi Chamber, several of which contained *Homo naledi* fossil deposits, including the U.W. 108 locality[13]. While Elliott et al.[11(p.16)] state that 'geological and speleological investigations both on the surface and underground have failed to find another entry into the area' (aside from The Chute), their discussion refers only to an aboveground survey. To my knowledge, a vertical section of the current extent of the system has not been published, but it is clear, at least from the plans, that the system is a complex set of parallel and perpendicular vertical fissures in the dolostone, each apparently with distinct sedimentary fills. The nature of these – including collapsed dolomite blocks – 'makes it difficult to determine how deep the fissures penetrate'[11(p.20)]. Although Elliott et al. refer to the fact that all but one of the newly mapped fissures are non-navigable (less than 25 cm in width), this would presumably be no obstacle while they were clear of fill, given that the team have been capable of descending The Chute, which narrows to 20 cm in places[12]. The possibility would presumably be easier still for the relatively smaller bodies of *Homo naledi* as for a baboon and owl.

Three localities deeper into the system than the Dinaledi Chamber (from the perspective of its current entrance) contained fossils pertinent to the discussion: the six skeletal elements of the baboon (U.W. 109), cranio-dental fragments of a juvenile *Homo naledi* individual (U.W. 110), and 33 elements including fragmentary long bones again consistent with *Homo naledi* (U.W. 111), all 'extremely difficult and remote localities' suggesting 'potentially different depositional events and processes from the…larger chambers'[11(p.21)], but these are all downslope from the Dinaledi and other chambers: would not a parsimonious interpretation be that *low energy* downslope mud movement during periods in which the cave system was *relatively* open (i.e. with no flowstone formation) account for the odd head or limb element penetrating into the system from a still not fully mapped fissure?

As flowstone activity – which continues today – has remodelled the cave interior, Dirks et al.[9(p.27)] acknowledge that an easier or more direct access to the Dinaledi Chamber may have existed in the past, although the sedimentology strongly suggests that the hominin-bearing matrix accumulated below the modern access point, but this rules out only the Dragon's Back route. As flowstone formation in the system seems to have occurred in discrete phases during the Middle Pleistocene[14], we might infer that the relative openness and closure of the chamber varied over this time: can another entrance (or more) be confidently ruled out?

The human remains

Much has been made of the *articulated* nature of some of the hominin remains: these include a lower limb of a child, a hand of an adult and two other partial hand articulations, an ankle, and at least four partial foot articulations.[1] As Val[5] argued, this is a very low proportion among a large sample of highly disturbed hominin remains, in fact lower

than the degree of articulation in a sample of *Australopithecus sediba* (minimum number of individuals =2) and could be explained by natural mummification, a process that Dirks et al.[1(p.151)] acknowledge they cannot rule out. Not that this need contradict the notion of funerary caching: in this light the curation of the naturally mummified remains of infants by their chimpanzee mothers reminds us that such remains can be carried around deliberately.[15] But these are articulated *body parts,* not bodies, even accounting for the post-depositional disturbance.

Remaining questions

The impressive work undertaken in the system to date continues to astound, and the team is narrowing down the possible interpretation for the introduction of the *Homo naledi* material into the cave. The funerary hypothesis certainly cannot be ruled out, and if anything it seems to me that the team nudge closer to firming up a justification for this. I'm *nearly* convinced, but not quite. Three questions for the team come to mind:

- Can one definitively rule out a different and as-yet unmapped entrance into the Dinaledi Chamber (whether or not it facilitated natural deposition of the hominin remains)?
- Is there any evidence of artificial lighting in the cave system, e.g. torch wipes, charcoal fragments or soot trapped in carbonate deposits?
- Is there evidence that it was dead *bodies,* rather than *body parts* that were carried into the chamber?

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