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Commentary

No scientific evidence that *Homo naledi* buried their dead and produced rock art

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1. Introduction

The Rising Star Cave system has yielded a stunning concentration of hominin remains estimated to belong to more than 15 individuals representing all age groups, assigned to a new species, *Homo naledi* (Berger et al., 2015; Dirks et al., 2015). Previous publications (e.g., Dirks et al., 2015; Randolph-Quinney, 2015), as well as popular interviews with the team leaders have suggested that *H. naledi* was engaged in deliberate disposal of the dead. However, other researchers have cited geological, taphonomic and paleontological evidence to suggest that natural formation scenarios may account for skeletal accumulations, such as a natural death trap, water transport of bodies/body parts and carnivore activity (e.g., Val, 2016; Stiner, 2017; Egeland et al., 2018; Pettitt, 2022).

In June of 2023, the journal eLife hosted three reviewed pre-prints by the Rising Star research team claiming that the Dinaledi and Hill Antechamber skeletal remains indicate deliberate burial practices and the production of associated rock art (Berger et al., 2023a, 2023b; Fuentes et al., 2023)[1]. Both the reviewed and previously unreviewed pre-prints were accompanied by a strong media campaign that quickly spread the revolutionary idea that the small-brained (~450–600 cc) hominins found deep in the Rising Star Cave system were capable of complex funerary behaviors equivalent to those attributed to larger-brained (~1400 cc) hominin species, *Homo sapiens* and *Homo neanderthalensis*. The media hype that accompanied both the unreviewed and reviewed, though currently unmodified, pre-prints at the time of this writing, triggered strong public controversy and an immediate debate about 'modern human behavior' but also about the way in which scientific work is communicated and perceived by the public (e.g., Gibbons, 2023; Petraglia et al., 2023; Zimmer, 2023). Here we will examine the evidence for the alleged burials and the purported rock art presented in the three reviewed pre-prints together with a consideration of the open reviews published alongside them. The peer reviews were unanimous in considering the evidence inadequate in its present form. Despite this, these versions remain available and communicated to the press and social media without yet integrating any of the referee's comments.

Here we argue that the evidence presented so far is not compelling enough to support the deliberate burial of the dead by *H. naledi* nor that they made the purported engravings. Substantial additional documentation and scientific analyses are needed before we can rule out that natural agents and post-depositional processes are responsible for the accumulation of bodies/body parts and to prove the intentional

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[1] The source of the quotations from the pre-prints by Berger et al. (2023a, 2023b) is given in the References section, along with the date accessed.

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excavation and filling of pits by *H. naledi*. Moreover, detailed analyses are needed to demonstrate that the so-called 'engravings' are indeed human-made marks and that, like the purported evidence of fire use, they can be securely linked to *H. naledi*. Our commentary also offers a brief insight on the state of the field regarding the importance of responsible social communication and the challenges brought by new models of scientific publication.

2. The alleged burials

According to Berger and colleagues (2023a), recent excavations at the Rising Star Cave system have provided evidence of at least three burial features, two in the Dinaledi Chamber (Features 1 and 2) and a third in the Hill Antechamber cavity. The investigators claimed that these three features represent the earliest evidence of deliberate burial by a hominin species, and that *H. naledi* intentionally carried the bodies of at least three individuals deep inside the Rising Star Cave system, dug pits, deposited corpses inside the pits, and covered the bodies with sediments.

2.1. Anatomical evidence

Burials are frequently defined on the basis of the intentional excavation of a pit, the anatomical alignment of bodies within the feature, and the infilling of the grave to protect the body (e.g., Henry-Gambier, 2008; Duday, 2009; Pettitt et al., 2011; Sandgathe et al., 2011; Martinón-Torres et al., 2021). In a deliberate interment, the body is generally articulated, and minimal skeletal displacements can be explained as a consequence of in situ decomposition (Duday, 2009). From the evidence available at Rising Star Cave, we infer that the hominin bones are not articulated but scattered (see Berger et al., 2023a: Fig. 4). In the best-case scenario, we can infer a general spatial association of some isolated skeletal elements and the articulation of some body parts (not bodies) such as an ankle and partial hand and foot articulations (Kruger et al., 2016; Berger et al., 2023a: Fig. S22). This scenario would be compatible with an in situ decomposition of bodies/body parts, a process that can occur in the course of natural mummification (see Val, 2016) of bodies/body parts that could be deliberately or accidentally accumulated by natural agents. In order to claim a primary deposit, it is necessary to prove the anatomical integrity of articulations and that the minimal displacement of the bones within the cadaver can be explained within the course of decomposition. This is not the case for the Rising Star Cave findings, where the scattering of the elements implies they were not covered/protected after placement, preventing a reliable reconstruction of the original position in which the bodies were theoretically laid in the cavities. Intentional burial is commonly associated with flexed or recumbent positioning of the skeleton, a disposition that can hardly be achieved by chance, thereby denoting careful placement of the deceased. From the evidence presented, the skeletons found at the Rising Star Cave are not articulated and therefore a reliable reconstruction of the original position of the bodies/body parts cannot be assessed, especially as some remain unexcavated.

Dinaledi Feature 1 is described as an interment of a single individual on the basis that the elements are unduplicated. However, Berger and colleagues (2023a) acknowledge the intrusion of at least two skeletal elements that would belong to a juvenile individual (that is described as being directly above and in physical contact with Feature 1) and a third one which, despite being in the immediate vicinity of Feature 1, is considered to be "out of anatomical placement overlying the uppermost part of the north side of the feature" (Berger et al., 2023a). The discretional exclusion of remains that are not consistent with the interment of a single individual questions the lateral and upper limits of a clear-cut burial pit and advocates for a more complex post-depositional scenario, including disturbances such as trampling. Moreover, Berger et al. (2023a) state that "without fully excavating the feature, it is difficult to test hypotheses about the original position and subsequent decompositional collapse of the skeleton" though they conclude that the "body was in a tightly flexed position". We agree that without a full excavation of the feature, and in the absence of a proper assessment of the orientation of skeletal specimens via 3D modeling and 3D rendering of the excavation stages or point-provenience (e.g., Chase et al., 2010; Martinón-Torres et al., 2021), it is impossible to evaluate the degree of completeness of the body/bodies, their original position and the limits of the purported excavated pit. In the absence of this information, the claim for deliberate burial must be rendered premature at this stage.

Similarly, Dinaledi Feature 2 is defined as a small concentration of bones claimed to represent a burial based on the assertion that the excavated material "seemed to come from a single body" (Berger et al., 2023a). Surprisingly, the burial finding is based on the identification of only six poorly preserved bone fragments which cannot be anatomically associated as they apparently belong to spatially distant anatomical regions, i.e., femur/tibia, cranium and zygomatic arch/vertebral lamina. As with Feature 1, Berger et al. (2023a) indicate that the feature has not been fully excavated, making obvious that the evidence to support a claim for deliberate burial has not yet been shown.

The Hill Antechamber burial feature includes remains of at least four different individuals whose spatial distribution overlaps (e.g., the postcranial elements of an infant and the teeth of a second individual are located immediately next to the articulated hand of so-called Individual 1; see Berger et al., 2023a: Fig. 2). The purportedly flexed position of Individual 1 is based on the attribution of all of the postcranial elements to the same individual, without discussion as to how the investigators ruled out its attribution to any of the other three individuals, particularly the other juveniles discovered within the feature. The evidence has not been presented to the readers in a detailed enough manner to assess the claims. The study fails to provide descriptive and quantitative data that supports or rules out the assignment of the isolated elements to one or another individual. Body parts found in different 'features' or chambers are directly assumed to represent different individuals. However, there is no discussion of the possibility that some of the body parts belong to the same hominin and are simply scattered because of abiotic agents such as water transport. Dirks et al. (2015, 2017) document significant water flow through these deposits and into drains in the floor of the caverns that could themselves have caused sinkholes and movement of bone through water transport and subsidence. Importantly, most of the specimens catalogued in Berger et al. (2023a) are unexcavated and/or uncleaned, preventing a proper assessment of skeletal completeness or articulation, as well the necessary biometric and physical comparison needed to evaluate overlapping anatomical segments and the minimum number of individuals. We understand that the delicate nature of some of the specimens may prevent a full physical excavation of every skeletal specimen but the combination of conventional and virtual excavation methods (see Martinón-Torres et al., 2021) is far from reaching its full potential without producing "unnecessary destructive excavation or preparation" (Berger et al., 2023a: Supplementary Information 2). In the hypothetical scenario that excavators consider that the information cannot be recovered without endangering the integrity of the specimen, they should simply acknowledge that the data is not available to study, instead of assuming that it exists and would favor their preferred hypothesis.

2.2. The pits

The identification of an intentionally excavated pit is a key criterion for recognizing a hominin burial (Deffleur, 1993; Henry-Gambier, 2008). Berger et al. (2023a) propose that the three 'burial features' are anthropogenically formed cavities where bodies were deposited and subsequently filled in. They base their statement upon 1) stratigraphic discontinuity and 2) geochemical differences between the sediments inside and outside of the features. As explained below, these facts cannot be easily extracted from the data available in their online papers.

The disruption of the stratigraphy refers to the apparent

discontinuity of a laminated orange-red mud layer which gets fragmented and muddled at the level of Dinaledi Chamber Feature 1 (Berger et al., 2023a: Fig. 3), supposedly a result of *H. naledi* digging a hole. Unfortunately, only a ca. 10 cm length of the laminated orange-red mud is shown in one of the profiles of a purported pit; therefore, it is not possible to assess the further extension and lateral continuity of this layer. The visibility of its limits is inexplicably obscured by a large black square holding the scale in both Figures 3A and 3B of Berger et al. (2023a). In previous studies (Dirk et al., 2015, 2017), the laminated orange-red mud was described as having a patchy distribution (i.e., discontinuous) in the Dinaledi Chamber and being subject to in situ auto-breccification and erosion (i.e., no anthropogenic action). It is not clear why the breccification level associated with the 'features' cannot respond to the same nonintentional mechanisms. Additionally, from the photographs provided (Berger et al., 2023a: Fig. 2, and Figs. S17 and S19), the chaotic and fragmented distribution of the orange clasts seems to extend well below (Berger et al., 2023a: Fig. 2) and lateral (Berger et al., 2023a: Figs. S17 and S19) to the accumulation of the skeletal remains. This means that from a sedimentological point of view, the lower and lateral limits of the alleged pit are not clear or have not been found/reached yet. Detailed micromorphological analysis of the sediment would be needed to help define the nature of any burial cuts and the formation and disruption of these units and to exclude natural features caused by floor drains or water table rises as suggested by Dirks et al. (2015).

In the case of Dinaledi Feature 1, the nature of the stratigraphy would mean that the body was not deposited at the bottom of the cavity. If a cavity is intentionally formed for the purpose of burying a body, it would be logical to place the corpse at the bottom of the pit before infilling was carried out (see Sandgathe et al., 2011). If bodies are transported into a naturally formed cavity, it would not be necessary to remove the existing infill to make room for it. In the case of the Hill Antechamber, the almost vertical position of some skeletal remains suggests the unlikely scenario of *H. naledi* digging a more vertical than horizontal depression. The inclination of this hollow would not be characteristic of an intentionally dug pit. The unclear limits and the irregular shape of the pits suggests that natural hollows and cave floor irregularities were filled in by gravity or transported by mud-flow containing bodies/body parts. Such processes of cave floor erosion, and removal of sediment down drains in the cave floor, causing subsidence and slumping were already outlined from the chamber by Dirks et al. (2015). This would explain the accumulation of more than one body in the same 'feature' and the non-anatomical arrangement of the overlapping skeletons.

The geochemical and textural sedimentary differences mentioned in Berger et al. (2023a) can be related to the obvious fact that they are comparing fossil-bearing vs. non-fossil bearing sediment matrixes (Berger et al., 2023a: Fig. 3) instead of the sediment within vs. outside the purported pit. In addition, relevant methodological flaws including the impossibility of replication of some of the analyses have been reported (see Reviewer 4 comments in Berger et al., 2023a). Thin section soil and bone micromorphological analyses would have been a helpful way to assess the specific genesis of the sedimentary matrix of the bones and to elucidate differences in the sedimentary processes and post-depositional disturbances, as well as determine if the bodies were laid down as part of the same event or at different times.

2.3. The stone artifact

The Hill Antechamber feature is said to contain a single, but distinctively tool shaped artifact (HAA1), in close contact (Berger et al., 2023a) or in direct association (Berger et al., 2023b) with an articulated hand and wrist elements. The stone object was encased in the larger plaster jacket containing the skeletal elements. The rock was synchrotron scanned, producing a 3D model, though not available for study with the naked eye or detailed microscopic analyses.

Given the data provided in Berger et al. (2023b), it is not possible to rule out the strong likelihood that this stone object is a geofact (Chatters et al., 2022), a natural product of cave wall exfoliation. The piece is suggested to be dolomite—the same material as the cave walls. The morphology and size of the piece is consistent with exfoliated pieces found in Rising Star Cave (see Dirk et al., 2015), as it is long (138.5 mm), narrow (49 mm) and thin (26.3 mm). The large scar (80 mm) on the anterior face is consistent with natural fractures, and the "depressed surface" on the posterior surface, possibly representing a "worn flake removal" (Berger et al., 2023a: Supplementary Information 3.2), is not distinctive. The so-called striations and serrations on the artifact, which are said to be from either use wear or erosion, are likely natural features of the dolomite. Indeed, the striations on the anterior and posterior surfaces match up and appear to run through the interior of the raw material meeting to form the so-called edge serrations. The investigators do not demonstrate any of the classic signs of stone tool percussive flaking, such as a striking platform, a bulb of percussion and ripples, providing little confidence that this object is cultural. The authors could surmise that the stone piece was struck from the cave wall by *H. naledi* or opportunistically used as a tool. However, the rock is still encased in sediment and thus unavailable for detailed microscopic analysis, including wear traces analysis and petrology; therefore, the artifactual status of this object remains unsubstantiated. Furthermore, Berger et al. (2023b) compare the shape of the Hill Antechamber rock to a stone artifact from Blombos Cave that was adorned with ochre. It is not clear why this is meaningful in any way. The Blombos example is a piece of flaked silcrete that is not the same raw material as the host rock at Blombos, indicating that the artifact was clearly transported into the cave. If the rock from Rising Star Cave is a piece of the host dolomite bedrock as suggested by Berger et al. (2023b), the two would be very different in both their nature and shape. Until the rock from the Hill Antechamber is properly studied, these types of statements and comparisons cannot be made. Despite previous claims (Berger et al., 2017), no evidence that *H. naledi* might have made Acheulian and/or Middle Stone Age stone tools has been made available to date.

2.4. Fire evidence

Fuentes and colleagues (2023) indicate that carrying of the deceased into the dark interior locations of the cave and the production of engravings would have required a light source. This statement disregards that other senses beyond sight, such as touch, smell or the feeling of air currents can help to navigate in the dark, and do not necessarily require the use of fire. Furthermore, the degree to which the interior chambers were dark remains debated (see Val, 2016; Robbins et al., 2021; see also Section 4). More importantly, no scientific evidence (e.g., Fourier-transform infrared spectroscopy, micromorphology, archaeomagnetism) has been presented to indicate the occurrence of in situ burnt material, let alone hearths. Previously acquired radiocarbon dates obtained by the site investigators on one of the apparent hearths resulted in very young dates (Lee Berger, unpublished data), questioning its association to *H. naledi*. Moreover, the occurrence of charcoal is also common in caves, including in South African landscapes, where there are frequent wildfires (Weij et al., 2022), so finding burned material in a cave setting does not automatically indicate anthropogenic activity. As with the 'stone tool', without any scientific evidence backing up this claim, the possibility of use of fire by *H. naledi* cannot be minimally considered and remains entirely speculative.

3. The purported rock art

Rock art engravings were reported in three locations on the dolomitic walls of a natural pillar that form the entrance and exit of a passage connecting the Hill Antechamber with the Dinaledi Chamber (Berger et al., 2023b). The incised markings were described as deeply impressed cross-hatchings and other geometric shapes (squares, triangles, crosses,

and X's). The claim is made that the surfaces with the engravings appear to have been prepared and smoothed, using percussive blows by a hard object, the application of sediment before and after the etchings and engravings were made to create visual contrast, and residues that created a sheen, possibly representing repeated handling or rubbing of the rock—though no evidence (grooves, tool marks, incisions, etc.) is provided to support this hypothesis.

With respect to the intentional covering of the engravings with mud or sand from the cavity, it is not unusual to find dolomitic sand in caves whose origin is in the natural dissolution processes of the bedrock (Aranburu et al., 2018). Moreover, it is common to find evidence of such dissolution (dolomitic sand or decalcification clays) in the cracks and fissures of the bedrock in which the karst cavities develop.

In their examination of the engraved marks, Berger et al. (2023b) note that the manufacture of the lines would have required an implement of equal or greater hardness than the dolomite. They note dolomite rocks of appropriate size and morphology to mark the cave walls have in fact been recovered from surface contexts within the Dinaledi subsystem, as have many chert fragments, but no further information is provided.

The investigators indicate the engravings date to 335–241 ka, as evidenced in the title of their paper (Berger et al., 2023b), but no dating information is presented. Indeed, the authors indicate that they cannot date the engravings owing to lack of calcite formation, though no information or data is presented. The investigators indicate that the time-ordering of the engravings and the temporality of surface treatments may imply multiple episodes of formation. Despite the ages presented in the title of their paper, the researchers admit that it is challenging to prove the engravings are contemporary with the ages that they have published for *H. naledi*, suggesting the possibility for earlier or

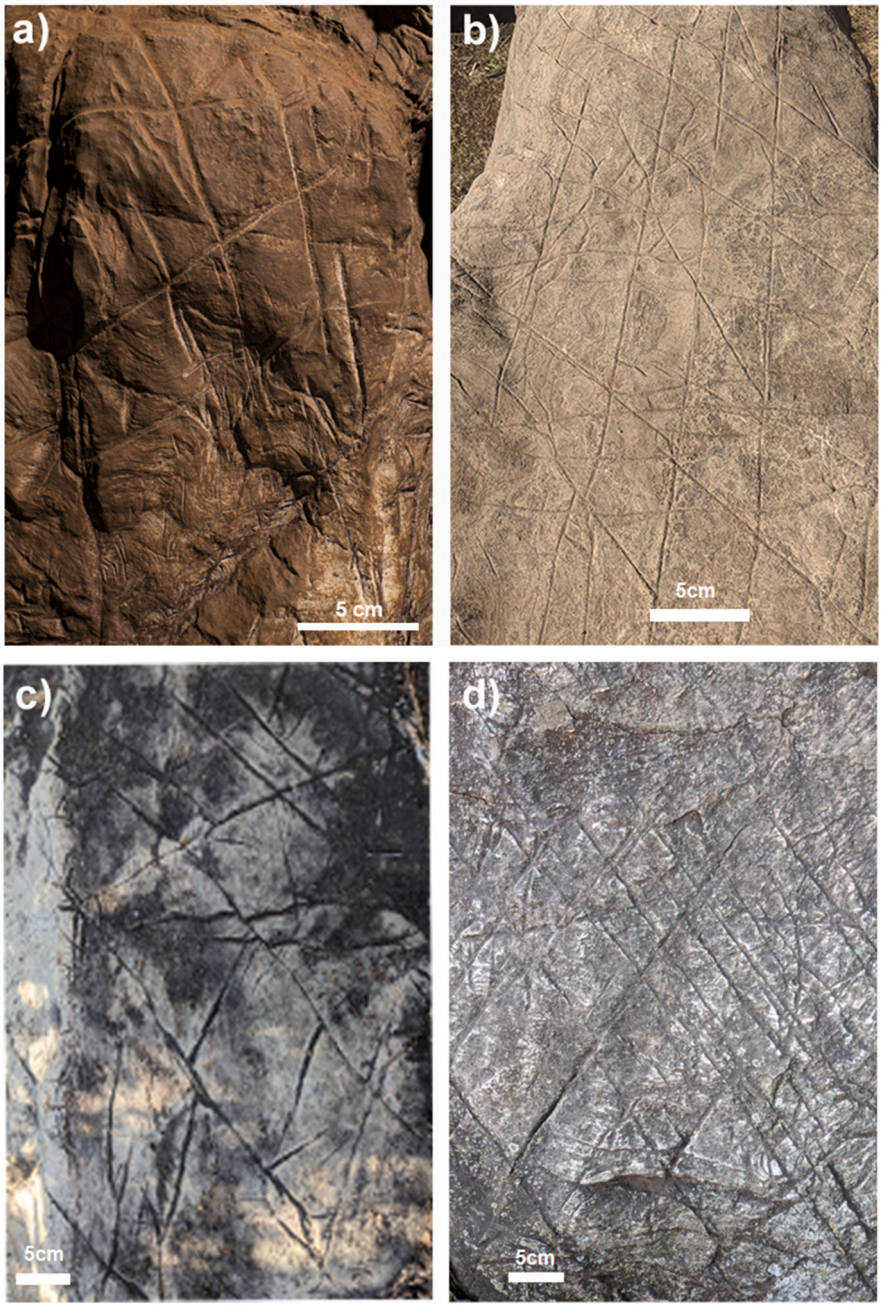

Fig. 1. A comparison between: (a) purported geometric rock engravings at Rising Star Cave as suggested by Berger et al. (2023b: Fig. 10) versus natural weathering of the dolomite at the Drimolen paleocave complex (b–d) that has created similar geometric cross-hatched patterns that are not of anthropogenic origin.

later visits (see Section 4). Despite all of these significant uncertainties, and the acknowledged lack of scientific analyses, the notion that *H. naledi* made 'art' was published (explicitly covered in the title) and publicly presented.

3.1. The engraved incisions

Berger et al. (2023b) state that natural fissures and erosional features in weathered dolomite surfaces are characteristically deeper than several millimeters and they follow natural fracture planes within the rock, whereas "Artificial lines are limited in depth and extent due to the natural hardness of dolomite" (Berger et al., 2023b). However, numerous examples of shallow cross hatched and patterned natural erosional lines can be found throughout the Malmani dolomite, the geological formation that hosts Rising Star Cave and all the other Plio-Pleistocene hominin fossils in the region (Murszewski et al., 2019; see Fig. 1 for examples). The parietal marks are better understood as processes of wall alteration than as incisions of anthropogenic origin. The orientation of the grooves is identical to the arrangement of the galleries and stratification planes of the cavity. The faults and fissures of tectonic origin are observed along the exokarst, which are frequently covered by calcium carbonate. Some of these naturally occurring breaks and folds are smaller in size to the fractures and faults observed in the karst of the Malmani subgroup (Button, 1973; Clay, 1981), giving rise to fissures and cracks that appear to be geometrically ordered (Fig. 1). This process is common in limestone rocks and especially in dolomitic rocks, both inside and outside caves, and is well known and studied in geology (López-Horgue et al., 2010). The authors reinforce their idea of an anthropic origin of the marks by alluding to the whitish color of their edges as evidence of a later reworking. However, dissolution is very common in caves (Zupan Hajna, 2003), generating an effect similar to those reported in Rising Star Cave (see Fig. 2). In fact, both the width and the depth of the grooves are not uniform along their length, something that is normally achieved anthropically.

The investigators present a series of four sub-parallel and vertical lines, arched in the upper section and with a pointed start to the markings at their uppermost point. These are similar to classic claw marks of cave-dwelling animals. As we explain in Section 4, various types of animals have been documented inside cave systems and therefore pose questions regarding the anthropic origin of the purported marks as well the inaccessibility to the Rising Star system to any other species than *H. naledi*.

4. Accessibility to the Rising Star Cave system and non-*Homo naledi* intrusions

In relation to the purported engravings and fire use by *H. naledi*, one argument made by the investigators is that the cave system was hardly accessible and that only *H. naledi* could have entered into the deep recesses at that time. While Berger et al. (2023b) provide a list in their Table 1 of "known humans who have entered the Dinaledi system (in approximate order of entry)", this is not consistent with statements made previously with regard to the cave system and its use by cavers. The Rising Star Cave system, also known as Empire of Westminster Cave, has been used by cavers since the 1960s for recreational caving, and the occurrence of survey pegs and arrangement of bone in the chamber indicates that an unknown number of unknown cavers had been into the Dinaledi and related chambers previously (Dirks et al., 2015). Neil Ringdahl is the first person listed as having explored the area in the 1990s, but he has indicated that the survey markers found in the chamber were not his (Tucker, 2015). It therefore cannot be ruled out that any potential engravings or fire-use evidence are the work of recent humans in the system. And not only humans.

In the case of European caves, the clawing by cave bears and even of animals still present in the caves, such as badgers or bats, is very well known and documented (Camarós et al., 2017). There are experimental programs and studies that characterize animal markings (Lorblanchet and Le Tensorer, 2003), apparently similar to the ones presented at Rising Star Cave (Fig. 2). In Oceania and Australia, claw marks were made in caves by marsupials, including the extinct marsupial lion *Thylacoleo carnifex*, as have markings by contemporary wombats and bats (Arman and Prideaux, 2016). With respect to South Africa, a range of modern species use the dolomite caves including leopards, porcupines, baboons, vervet monkeys, hyaena, jackal, honey badger, kudu, and sable (Bountalis and Kuhn, 2014). As outlined by Elliot et al. (2021), a partial baboon skeleton is known from the Chaos Chamber that links to the Dinaledi Chamber making it clear that in the past, animals other than hominins were venturing into the chambers of the Rising Star Cave system beyond the Dragon's Back Chamber. The baboon tooth, from Unit 3a, was dated to 723 $\pm$ 181 ka and the uppermost flowstone was dated to >780 ka based on paleomagnetism. This suggests the chambers had once been filled almost completely with sediments before they were eroded out. It seems unlikely that the juvenile partial baboon skeleton noted by Elliot et al. (2021) comes from this older period as it is unlikely to have survived such processes in some form of articulation. Elliot et al. (2021) state that its occurrence is unsurprising given that baboons are known to utilize caves in the region. But if this were true, then why is the occurrence of *H. naledi* material in this area of the cave deemed so exceptional? What about the purported inaccessibility?

Moreover, recent studies by the Rising Star Cave team also point to a possible different and easier accesses for *H. naledi* into the fossil-bearing cave chambers than the current restricted access chute used by the research team, making clear that the degree of accessibility remains an open question (Robbins et al., 2021). Based on extensive dating studies of speleothem, this research (Robbins et al., 2021) implies that prior to 241 ka and the collapse of the Dragon's Back block hominins and other species could have more easily entered the cave via the Post Box Chamber and beneath the Dragon's Back Block before it fell. This gives access to a series of rifts that allow easier entry to the Dinaledi and other chambers beyond the present-day chute.

In sum, available information indicates that animals have frequented the caves of South Africa, leaving their markings there as they have done elsewhere on the planet (see Fig. 2 and Section 3.1).

5. Concluding remarks

There is no convincing scientific evidence to indicate that *H. naledi* buried their dead and produced rock art in the Rising Star Cave system based on the information thus far presented. As explained here, the investigators have not employed the wide range of scientific methods (e.g., chronology, taphonomy, sedimentology, micromorphology, geochemistry) designed to answer the questions posed nor applied the basic principles of archeothanatology to identify a deliberate burial. We understand that the extraordinary accumulation of hominins and signs of in situ decomposition of bodies or body parts calls attention to the possibility that *H. naledi* may have engaged in some type of proto-funerary behavior. Yet, in light of the accumulation of these skeletal deposits, we believe that natural and post-depositional agents have not been seriously considered and ruled out, especially when the partial skeletons of nonhuman primates also occur within the chambers. The complex geological and sedimentological dynamics described by the team for the Rising Star Cave system involve erosion, sediment slumping and drainage (see Wiersma et al., 2020). However, the possibility that these processes could contribute to the transport and scattering of sediments and/or animals is not properly discussed.

We are aware that 'necroclaustralization', i.e., the covering or 'claustral enveloping' of dead bodies is not a unique behavior to humans and could be a precursor to burial (Pettitt, 2018), although the motivation driving this behavior is unclear and could be diverse (e.g., sanitary reasons, avoiding the attraction of predators, revulsion, or religious). As an example, ants carry and accumulate the dead bodies of their counterparts outside their nests and cover them with sediment, and

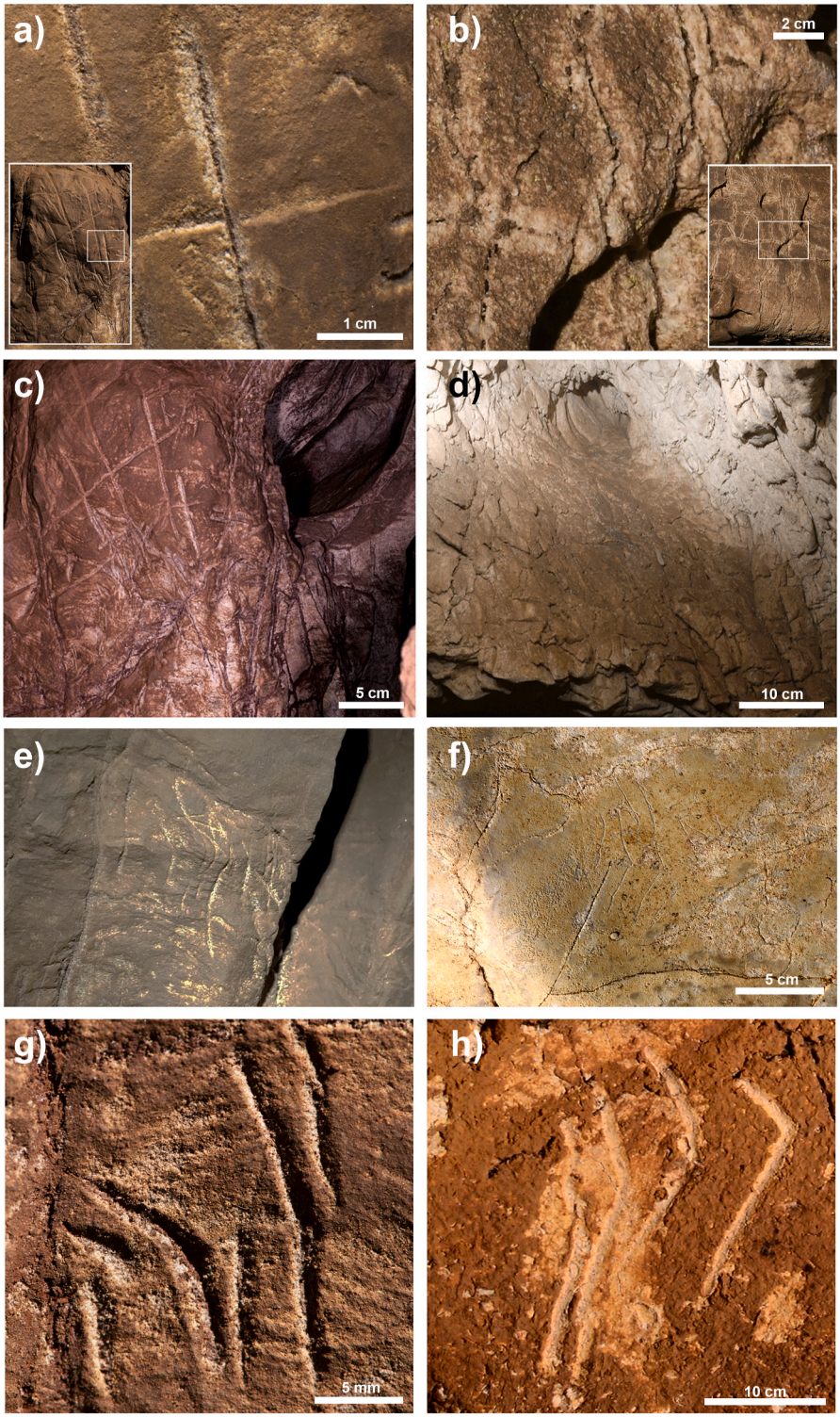

Fig. 2. Detail of the dissolution processes in the fissures, interpreted as engravings by Berger et al. (2023b), but clearly natural in other cases: a) Rising Star Cave (Berger et al., 2023b: Fig. 6); b) Chufín Cave (Spain). Homogeneous clay layer covering the rock surface by natural precipitation. There are no traces of human application to the matter: c) Rising Star Cave (Berger et al., 2023b: Fig. 2); d) Chufin Cave (Spain). Vertical lines with a curved development at the top. These are typical traces of cave animal claws inside the caves: e) Rising Star Cave (Berger et al., 2023b: Fig. 2, scale not provided); f) Chufin Cave (Spain) badger claws; g) Rising Star Cave (Berger et al., 2023b: Fig. 17); h) Chauvet Cave (France) cave bear claws.

chimpanzees have been described as cutting and throwing leafy branches over the corpses of their conspecifics (Boesch, 2012; Pettitt, 2018). The evidence of burials as a form of necroclaustralization is less common in early stages of human evolution and requires an additional effort by choosing/creating a specific place for the accommodation and covering of the deceased to protect its integrity, denoting stronger emotional or symbolic attachment. Interestingly, burials are commonly found in social spaces that were important to the living or that have been given a special meaning (e.g., Stiner, 2017; Martinón-Torres et al., 2021), whereas funerary caching tends to be in places of difficult access,

even if the motivation is not clear. Why would *H. naledi* take the effort to bury the bodies in an already deep and supposedly hardly accessible location? This combination (difficult location and burial) would be a major undertaking for any species and, to our knowledge, it has not been reported in any other animal beyond *H. sapiens*.

If the intention of the Rising Star Cave team is indeed to characterize some type of complex funerary behavior by *H. naledi* species (Berger et al., 2023a, 2023b; Fuentes et al., 2023), we should be able to recognize gestures that are stereotyped or 'ritualized' in that they follow a predictable pattern (Stiner, 2017). Why were some of the individuals buried and why were some not? Why is the case made for burial of one of the individuals within a 'feature', but not for others despite the fact that they are located in close proximity? How are these three burial features related to the multiple skeletal remains found in previous excavations and in the immediate vicinity and in the nearby cavities? The selective reporting and consideration of the evidence that fits their preferred hypothesis is misleading for the readers and the general public.

A fundamental problem, also unanimously outlined by the peer reviewers of the three papers, is that the authors have chosen a null hypothesis that is the less parsimonious one. The null and alternate hypothesis procedure aims to challenge current conventional thinking, i.e., complex funerary behaviors are associated with large-brained species. In scientific standard practice, the null hypothesis needs to be tested and refuted before we can build on an alternate hypothesis, i.e., a small-brained species is responsible for complex funerary behaviors. Surely the finding of articulated bodies is compatible with both scenarios (natural and deliberate accumulation) but the hypothesis that needs to be refuted is the more parsimonious one (natural). This would be epistemologically equivalent to choosing as a null hypothesis that my house was made by aliens instead of humans. Which maker is the one that should be questioned? Which statement is the challenging one? The authors have built a misleading, but persuasive discourse, where they do not test their hypothesis but selectively report the evidence that supports their preferred scenario (see Corneille et al., 2023 and Reviewer 4 of Berger et al., 2023a).

As a site of major human evolutionary significance, Rising Star Cave should no doubt attract tremendous global attention. We understand and praise the efforts to bring to a broad and general audience the importance of the scientific findings. Science communication is becoming a more important component of science and this obliges us to undertake serious consideration of its role and its rules. We would thus like to end by reflecting on the dangers of communicating or overselling conclusions before the evidence to sustain them is ready, especially if the tentative nature of the findings is not specified with enough clarity.

Scientists and the media hold a scientific and social responsibility in the way in which they perform and communicate science, particularly if the evidence that we hold is susceptible to provoking a paradigm shift. There are no acceptable shortcuts for high-quality science. In an era under the menace of fake news and misinformation, we should be careful of crossing the line where premature and incomplete information is presented as evidence as it devalues solid science and the building of knowledge. The controversy triggered by the publication of the Rising Star Cave papers is also related to the eruption of new publication models as an alternative to the classic peer-review system. These new models allow for the publication and sharing of non-peer-reviewed or even reviewed but rejected papers, adding an element of confusion in the communication of evidence-based knowledge to society at large. Such publication models have been promoted under the need for a faster and perhaps more transparent procedure of revision and publication of scientific works, but they bring the added danger of presenting premature or unstained conclusions for the sake of 'transparency' or to attract public attention.

We strongly believe in and support open science, but open science means that the evidence upon which hypotheses are built should be available to the scientific community and in such a way that the results can be replicated by other researchers. In the case of Rising Star Cave, it is clear that the evidence that would demonstrate that *H. naledi* buried their dead and made art has not yet been presented despite this notion has been openly shared with the public. Engaging in 'open research' practices in a superficial manner and deviating from what is essential (i.e., sharing the evidence that would allow for reproducibility of the same experiments or reaching the same conclusions) could turn 'open science' into 'open research washing' to boost the perceived robustness of the work (Corneille et al., 2023). We should not mistake open science with open opinion, where social media, outreach events and blogs are considered scientifically valuable and more appropriate vehicles for knowledge growth. Would it be acceptable to prematurely publish and spread untested results if these could have an effect on health and well-being? We advocate that the standard for scientific rigor should be the same in all fields, and we hope this Commentary will stimulate a deep reflection on how the peer review system can adapt and participate in the contemporary world and debates.

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