Abstract

In 2016, an extraordinary burial of a young adult individual was discovered at the Late Pre-Pottery Neolithic B (LPPNB, 7,500–6,900 BCE) settlement of Ba’ja in southern Jordan. This burial has exceptional grave goods and an elaborate grave construction. It suggests discussing anew reconstructions of early Neolithic social structures. In this article, we will summarize former theories on the emergence of leadership and hierarchies and present a multivariate model according to which anthropological and archaeological data of the burial will be analyzed. In conclusion, we surmise that early Neolithic hierarchization in southern Jordan was based on corporate pathways to power rather than self-interested aggrandizers. However, some aspects of the burial point to regional exchange networks of prestige goods, a trait considered characteristic of network based leadership. In line with anthropological and sociological research, we argue that pathways to power should be considered as relational processes that can be understood only when comparing traits of the outstanding person to her/his social environment.

Introduction

In 2016, a very elaborate single adult burial was discovered at the Late Pre-Pottery Neolithic B (LPPNB) site of Ba’ja (30°24’48”N, 35°27’40”E) in southern Jordan (S1 Fig). Its outstanding characteristics, such as the elaborate grave construction and the exceptional grave goods, initiated a reconsideration of the emergence of early Neolithic social structures. In this article, we will summarize former theories on the emergence of leadership and hierarchies and present a multivariate model according to which anthropological and archaeological data of the burial will be analyzed. In conclusion, we surmise that early Neolithic hierarchization in southern Jordan was based on corporate pathways to power rather than self-interested aggrandizers. However, some aspects of the burial point to regional exchange networks of prestige goods, a trait considered characteristic of network based leadership. In line with anthropological and sociological research, we argue that pathways to power should be considered as relational processes that can be understood only when comparing traits of the outstanding person to her/his social environment.
many anthropologists still assign physical and coercive power as one of the main incentives to hierarchical organization with (aggressive) aggrandizers being considered the motor of social evolution [6, 11–12]. However, empirical support for the proposed universal link between offensive warfare and the emergence of states is still lacking [13–14]. There is increasing evidence in socio-political research that political leadership among small-scale traditional horticulturalists, but also in larger complex societies is achieved by enhancing cooperation with non-kin, by coordination of collective action, representation of group interests, as well as by successful conflict mediation [7, 14–18].

According to socio-anthropological research, two types of leaders thus seem to be at opposite ends of the scale (Table 1): leaders who gain power by informal modes of acclamation and others who conjure fear and apply coercion. The latter expect unlimited loyalty and legitimize their power by the "need" of their group for a "strong hand" to protect and guide them; in general, these types of leaders promote specific power-supporting confined group identities with clear-cut distinctions of one's own group and "strangers". Accumulation of wealth or its inequitable redistribution by the leading group may augment economic disparities between the leading group and the community. Ideocratic structures may promote these types of leadership more than communities in which relational social structures and habitus determine personal and social identities [19].

At the other end, there are leaders receiving and maintaining their power by non-enforced, but self-motivated optional acclamation from their peers for being good mediators able to steer peer pressures and coordinate interests as *primi inter pares* (as is characteristic for e.g. habitus societies *sensu* Gebel [19]). *Prototypicality* of the leader—the leader is perceptually assimilated to the group—and *social attraction* are said to be main factors in successful leadership ([20]; see also [21]). Although such groups are generally more heterogeneous than groups based on coercive power, social processes of imitation and popularization can lead to a rather homogeneous appearance but without strict canonization. The more equitable redistribution within this type of societies may lead to a more homogenous distribution of economic wealth. Moreover, borders tend to be less marked. Leadership by acclamation of the habitus-type (see above) requires more social negotiation and less ideocratic input [19]. Leadership can be “distributed across multiple group members or concentrated in a single individual” ([21], see also Definitions).

A rather similar distinction was made earlier in anthropological research. Following Renfrew’s [1] differentiation of group-oriented and individual leaders, Feinman ([22]; see also [23]) elaborated “two ends of a continuous range of pathways to power and inequality”: corporate and exclusionary strategies. Group-oriented (corporate) leaders gain their power via the support of their group members; power is less overtly demonstrated but instead shared in several social entities. In contrast, self-interested individuals (exclusionary strategies) gain their power through the support of their equals, from familial ties or other groups via a network of other aggrandizers. They rule autocratically and the “economic foundations of power tend to have their roots in the spoils of war, long-distance exchanges, or other forms of easily concentrated wealth.” These two different pathways to power affect how identities of leaders are conceived and publically manifested and possibly also on how group identities are represented by symbolic media: from architecture to rituals and imagery.

It goes without saying that such a division in two opposed types of leadership is a heuristic means and a strong simplification. Every community comprises many diverging agents of power such as informal and structural power, healing, magic, ritual and economic power. These institutions, groups or individuals may, but do not have to, converge with leadership.

The personal traits of the leader thus represent only one aspect of the social structures of leadership. To understand the character of leadership, it is necessary to consider his/her
relation to the community. Socio-neurobiological research and evolutionary anthropology have shown that accessing, establishing and maintaining power is always a relational process [20, 24]. Leadership depends on the prevailing discourse and ethical concepts. Even if new leaders deliberately represent themselves in clear contrast to traditional concepts, they are still children of their times (for a summary on social constructionism see [25]; for the Neolithic Gebel [26] used the term \textit{milieu}). This implies that pathways to power are not solely based on the agency, abilities and skills of power-seeking aggrandizers (\textit{cf.} [6, 11]), but also on the group and its socio-economic, ideological and natural environments (e.g. [18]). Even in non-autocratic societies, when conflict and fear of other groups increases, social processes can lead to the promotion of charismatic and even autocratic self-interested leaders [20, 22, 27]. These relational aspects of leadership have considerable consequences for the studies about pathways to power.

To gain insights and to understand the great variety of the processes of how human communities evolved from rather egalitarian systems to stratified societies, a diachronic approach is necessary and has to comprise (pre-) historic data of various case studies. Archaeological research about early farming communities can provide invaluable insights on how power was established at the transition to sedentism and production—one of the turning points of human history.

In the prehistoric archaeology of the Near East, social organizations of early farming communities have long generated a controversial discussion (e.g. [3–4, 19, 28–32]). On the one hand, it has been argued that a "centralized and powerful decision-making authority or
apparatus” would have been necessary to manage increasing population densities and organize living in permanent large-scale settlements [32]. Social alienation due to increasing population densities [33] made the mitigation of conflicts a crucial social requirement for the successful transition to village farming communities [26, 34–37]. Exchange of commodities might have contributed to the mitigation of emerging conflicts in productive milieus [26]. The possibility to accumulate, store, display, retain or distribute goods probably enhanced the potential to manifest and establish social differentiation by “objectification” [16–17, 23, 38]. Many archaeologists and anthropologists therefore still consider the beginnings of agriculture and the production of surplus or differential access to fertile land as the main driver of hierarchization ([4, 17, 23, 29, 39], cf. [11, 18, 40]).

Early Neolithic communities in the Mediterranean zone have been reconstructed as “territorially organized, non-egalitarian […] ‘tribes’” ([41], see also [3]) whereas groups of the arid zones were considered “egalitarian”. Burial rituals of the LPPNB suggested the veneration of specific persons, groups or sodalities [42–44]. Skull deformation might even indicate that a specific status was ascribed to some individuals at a very young age [45–46]. Imagery and communal architecture from Northern Mesopotamia have been interpreted as evidence for chieftain [30] or the dominance of clerical elite [47]. In a similar vein, for the developments during the LPPNB at ’Ain Ghazal, Rollefson [4] suggested “a social hierarchy based on religious control” (p. 150).

On the other hand, architectural homogeneity in the Levant and Central Anatolia as well as some burial practices have been interpreted as evidence for rather egalitarian structures that level emerging social differentiation [48–50]. Gebel [19] pointed out that the Neolithic relational communities of the southern Levant tended to promote flat hierarchies, in which leading community members cooperated in the decision making processes for the community. This is in contrast to more ideocratic groups of the Northern Levant, which needed institutions to control doctrinal ethical or ideological concepts. These differences in interpretation are only partly due to different perspectives of research. They support the idea that there were multiple pathways to socio-political leadership driven by differences in environment, social conditions, mode of procurement and production as well as access to knowledge.

Considering these relational aspects of leadership and the obviously different pathways to power, our aim is to present the empirical evidence for the special burial from the LPPNB site of Ba’ja, in southern Jordan, in relation to the group and regional traditions. Within this theoretical model, the extraordinary single burial will be analyzed according to a catalogue of criteria (S1 Text). In light of these new empirical data, we will suggest a more detailed hypothesis on how hierarchical systems may have developed during the LPPNB in the southern Levant. Our conclusions should not be considered as universal, but rather contributing an example to the variety of incipient hierarchization [17, 28, 47, 50–51]. Our study aims to provide a systematic and holistic analysis as well as an understanding of emerging social differentiation.

Definitions
For this case study from the LPPNB, we prefer a neutral term—’outstanding person’—instead of the terms ‘powerful authority’ or ‘leader’ since we cannot specify yet the kind of power or status with which the person was endowed. Extraordinary burials should not be interpreted as “simple proxies for social structure” [18]. As we do not have any imagery or anthropological records that allow us to reconstruct the role of the person, it is not possible to judge from the archaeological data her specific power or function in society. What is observable about an outstanding person are anthropological specificities or a special status indicated by material wealth or specific objects. For the Neolithic, it seems anachronistic to differentiate between
social, political or spiritual leadership, despite the fact that these differentiations might have been emerging during the early Neolithic. In addition, the archaeological records do not yet allow a clear differentiation between these three analytical categories.

Prestige is understood here as achieved eminence due to extraordinary characteristics, skills, possessions or behavior of the individual. Social status implies a social rank or role regulated by conventions, duties and privileges of a social entity. In contrast to prestige, status can be inherited or achieved. Prestige often correlates with status but does not have to. People can hold a certain status without having prestige and vice versa.

Leaders are defined as “individuals who are accorded differential influence within a group over the establishments of goals, logistics of coordination, monitoring of effort, and reward and punishment. Leadership can be distributed across multiple group members or concentrated in a single individual” (p. 539) [21]. Access to power can range from prima vista covert influence to active coercion.

Following Willer et al. [52], we define chiefdom as a “kin-based ranked polity” (p. 427) with an institutionalized supra-local leading authority, irrespective of how power is achieved. This is in strong contrast to the definition by Carneiro [6] who considers chiefdoms as “first and foremost a political and military creation, a form of polity brought into being and held together with an iron hand by a successful war leader” (p. 26–27). Sharing the concerns of Morton Fried, we avoid the term “tribe” as descriptive for the structural characterization of a community since it refers rather to the kind of familial relationships within a community [4] than to characterize a socio-political entity. We therefore prefer to speak of segmentary communities for flat-hierarchical large communities to indicate that the segments of these societies are relatively equal, irrespective of whether the segments are clans, lineages or moieties or other social entities. Within these entities, ranking is often determined by age, sex, kinship or provenance.

We use doctrinal here as related to indoctrination of canonized forms of imagery, communication or belief systems [19]. Whereas some Neolithic communities of the Northern Levant seemed to support a doctrinal mode of communication and incipient ideocratic structures (sensu Gebel [53]), confined habitus communities of the Neolithic were characterized by repetitive daily practice that may have built, over time, strong traditions, almost identical to doctrinal media but based on imitation and transmission of corporate belief systems and habitus. This should not be confused with the differentiation of an imagistic and doctrinal mode of religion established by Harvey Whitehouse [54]. For the description of the ethos of Early Holocene communities from the Northern Levant, we prefer to use the more neutral term ideocratic [19], meaning the ruling of generally accepted and unreflected ideas promoting social coherence between groups not necessarily knowing each other [37]. This is different from Bourdieu’s term doxa that implies a societal ethos promoted and ruled by institutionalized authorities, such as priests, kings, military rulers, etc.

**Empirical data**

The Ba’ja Project was directed from 1997–2016 by H.G.K. Gebel (HGKG) and it has continued since 2018 under the co-directorship of HGKG, M. Benz (MB) and C. Purschwitz (CP) [55]. The outstanding Burial Loc. C10:408 was discovered in Room CR 35, Area C [56] (Figs 1 and 2). Despite structural similarities in grave construction to the collective burials of the site, it is the first primary single burial discovered in a clear settlement context at Ba’ja [57–59].

**Construction details of the grave and reconstruction of the ritual process**

The construction of the grave and the funeral ritual will be described in chronological order of events (Table 2). The place of the burial was chosen in the north-western corner of the room
in which two other burials existed or were later added (Event 1; [56]). Although the chronological order of the different burials remains unclear, they belong to approximately the same use phase. Loc. C10:408 is also close to Loc. C10:170, a collective burial in the adjacent northern room of the building. At first, a 72 cm (N-S) large and 60 cm wide (E-W) and about 50 cm deep burial pit was cut through the terrazzo-like floor Loc. C10:403 and its sub-construction of large pebbles (Loc. C10:410) into the hard playa-like natural sediment (Event 2). The pit partly undercut the wall (Loc. C10:78). The southern border of the pit was fixed with two vertical stone slabs whereas on the northern border a slight step had been dug into the sediment in order to place the grave cover on top. A low half-circular wall of stones was built confining the southern and eastern part of the grave. Probably during the burying ritual, a fire was lit on the floor (Loc. C10:403) adjacent to the burial (Event 3). The ash layer and traces of this fire could be clearly seen during the excavation between the floor and the grave’s final sealing (Fig 2B), but it decayed immediately after excavation. The sealing of this ash layer must have taken place immediately after the fire expired. After the corpse had been laid into the pit with its personal
belongings, a macehead had been placed next to his shoulder and deliberately smashed, so that it was broken in two halves and several small chips (Event 4) (Fig 2C). The grave pit was covered with three large overlapping red and white Ordovician sandstone slabs (Event 5, Fig 2B). Traces of charcoal were observed on the northern slab indicating the use of fire during the burial ritual (Event 6, see also Event 3). In a next step, large stones embedded in reddish-

![Fig 2. The burial of Loc. C10:408. a) with the embedded objects in the upper grave cover. Republished from ex oriente e.V. under a CC BY license, with permission from Hans Georg K. Gebel, 2017; b) with the stone slab cover, c) after uncovering the skeleton with its grave goods. (Photos: HGKG, MB).](https://doi.org/10.1371/journal.pone.0221171.g002)

Table 2. Reconstructed sequence of events for the burial ritual of Loc. C10:408, CR35 at Ba’ja.

| Events | Activities |
|--------|------------|
| 1      | Choosing the burial area in the north-western corner of the basement of Room CR 35. The space was probably transformed into a burial area, given that a double child burial (Loc. C10:405) and a collective burial (Loc. C10:152) were placed in the basement of this architectural entity too; |
| 2      | digging the pit through the terrazzo-like floor (Loc. C10:403) into natural sediment, partly below Wall Loc. C10:78; setting two vertical stone slabs on the southern border of the pit and aligning the pit’s border with a half circle of stone slabs; |
| 3      | lighting a fire outside the grave (if the fire does not relate to the burials of Loci C10:152, C10:405 or C10:170 next to burial Loc. C10:408 and in the adjacent room to the north); |
| 4      | burying the dead with its personal outfit, destroying the macehead; |
| 5      | covering the pit with three stone slabs; |
| 6      | use of fire or of charcoal on the stone slab (MAMS 30314: 8039 ±27 BP see Table 3); |
| 7      | covering the slabs with large stones and deposition of objects (flint dagger, arrowheads, pestle, stone bowl fragment, bone spatula); |
| 8      | covering with re-used terrazzo-like floor material, filling the gaps in the wall above the stone slabs |
| 9      | covering with dark-grey sand inside the stone slab half-circle; |
| 10     | adding white plaster on the southern edge (possibly originally extending over the whole grave–but not preserved); |
| 11     | decay of body with the head falling on the chest, turning the mandible upside down and possibly other slight taphonomic movements; |
| 12     | intrusion of fine sand and fine gravel and collapse of the stone slabs. |

* modified after Gebel et al. [56].

https://doi.org/10.1371/journal.pone.0221171.t002
brown sand were used to cover the slabs. Within this layer, several objects were placed (Event 7) (Fig 2A). At the end, the final sealing was added with a layer of reused flint- and limestone small-sized gravel that also partly covered the stone border of the grave and the ash layer (Event 8; see also Event 3). The gravel layer ran onto Walls Loc. C10:411 (in the south) and Loc. C10:78 (in the north). This observation proves that the burial was younger than both walls. On top of the gravel layer, a patch of coarse-grained dark-grey sand was deposited in the eastern part of the grave (Event 9). Finally, white plaster was applied, probably on the whole grave, even though it was preserved only in some parts (Event 10). Radiocarbon data confirm the use of this space as a burial area at the end of the LPPNB, between 7071–6684 cal BCE (95.4%) (Table 3). A possible old wood effect of the sample MAMS 30314 due to juniper charcoal cannot be ruled out. However, the date overlaps considerably with the date of a small twig (MAMS 30315) from the nearby double child burial Loc. C10:405, wherefore the probability is rather low. Both graves were dug into the same plaster floor but their precise stratigraphic relation remains unclear (Fig 1). This uncertainty and the plateau of the calibration curve obstructed further statistical operations (S3 Fig).

The completed grave construction formed a slight elevation of about 10–15 cm from the original floor (Loc. C10:403). Considering the collapse of the stone slab cover, it can be suggested that this elevation was even higher before the collapse. During decay (Events 11–12) the grave pit’s void was filled with fine-grained sand. The taphonomic processes of the corpse indicate a void, at least for a certain amount of time. Traces of gnawing from small rodents might corroborate this observation (see below). Under the pressure of the sediment and the middle stone plate, the southernmost stone slab also collapsed. This must have happened after the sand had infiltrated since the slab did not fall into the grave pit completely.

The individual

The individual was rather squeezed in the pit with its legs flexed (left femur 60˚, right 90˚) (Fig 3). The orientation was southwest-northeast. Both legs were turned to the left side. The right tibia was so close to the right femur that some kind of binding seems possible. The left arm was stretched below the legs with the left hand touching the eastern border of the grave pit. The right upper arm lay along the right rib cage and the right lower arm was flexed over the body with the right hand gripping the left upper arm. The torso was lying on its back and the skull had collapsed onto the chest, whereby the mandible had turned upside down. This twisted position of legs, arms and torso is hardly possible in vivo. It cannot be excluded that the legs fell to the left side after some ligaments had dissolved suggesting originally a sitting position.

Table 3. Radiocarbon data from burial Loc. C10:408 and the double Infant burial Loc. C10:405.

| Lab ID | Context | 14C age BP ±1σ | Δ13C AMS [%] | cal BCE 95.4% probability | C [%] | Material | Species |
|--------|---------|-----------------|--------------|---------------------------|-------|----------|---------|
| 30312  | Loc. C10:405 Ind II | No collagen |  |  |  | bone unburnt |  |
| 30313  | Loc. C10:408          | No collagen   |  |  |  | bone unburnt |  |
| 30314  | Loc. C10:408 BP 97415 | 8039 ±27     | -22.7±0.5    | 7071–6982 (54.3%), 6974–6911 (18.6%), 6853–6830 (22.5%) | 51.2  | Charcoal | Juniperus |
| 30315  | Loc. C10:405 BP 97422 | 7928 ±29     | -35.1±0.5    | 7028–6931 (19.5%), 6920–6877 (11.5%), 6806–6864 (64.5%) | 44.9  | Charcoal, twig | Juniperus |

Conventional ages (BP) were calibrated with Oxcal v. 4.3.2. [60], IntCal 13 [61] (S3 Fig), Δ13C values were measured in the accelerator and should not be compared directly with radiocarbon data.

https://doi.org/10.1371/journal.pone.0221171.t003
with the back leaning on the western border of the grave pit. However, the anatomically cor-
rect alignments of most bones—except for the head—do not suggest much taphonomic move-
ments. The skeleton is poorly preserved (Fig 4), the bones extremely friable and their surfaces
heavily eroded. All skeletal remains are deposited under the specimen number C10:408 in the
Department of Anthropology of the German Archaeological Institute and are accessible to
anybody upon request.

There are no clear markers for sex determination preserved except for a prominent glabella
(score 3–4) [62], relatively big teeth and a strongly built mandible. Taken together these crite-
ria give a slight evidence for a male individual.

For age estimation, dental wear [63] was considered although the environment of the sandy
plateau and surroundings suggests more severe attrition due to abrasive elements within the
diet. Dental wear of the molars points to an age of 25–35 years. The state of the cancellous
bone within the femoral head and neck is dense, which also suggests a young adult age [64].

Taphonomic features include rodent-gnawing marks and remnants of roots on the frag-
ment of the right scapula and very intense on the left femur (Figs 5–7). The surface of the
femur is additionally changed by erosive processes due to water and stones. Remnants of roots
are visible on the internal lamina of the right parietal too.

Joints of the spine are only scarcely preserved. Except the left lower joint of the atlas which
shows pitting of the surface and subtle enlargement of the rim (Fig 8), all joint surfaces are
without any pathological changes. The joints of the extremities (distal right humerus, proximal
right ulna, possible right patella, proximal right femur, right calcaneus, small joints of hands
and feet) are all without degenerative changes.

Only parts of the left maxilla and mandible are preserved, of the right side, only isolated
teeth are present for investigation. No statements about periodontal diseases could be made
due to poor preservation of the alveolar region. Apical processes seemed not to be present on
the left jaws. Calculus is present on all of the teeth to a low to moderate degree (Grade I-II,
after [65]) (Figs 9–12). There was no sign of carious lesions. When comparing molars and pre-
molars, dental wear is more pronounced on the left than on the right side of the jaws. Severe
dental wear is evident of the left incisors, canines and premolars (right side is missing). The
distinct difference between wear of the anterior and posterior dentition suggests work-related

---

Fig 3. Reconstructed virtual E-W-cut through the burial Loc. C10:408, facing south. * Embedded in the grave
cover, printed under a CC BY license, with permission of Marion Benz, 2018.

https://doi.org/10.1371/journal.pone.0221171.g003
use of the anterior teeth. Enamel chipping is present on 12 of 21 teeth, mainly in the posterior dentition. The chippings occur mainly singular from less than 1mm to 4x4mm in size (Fig 9). They might be due to hard substances within the food as they are predominantly affecting the

Fig 4. Preserved bones of the individual of Loc. C10:408. Dark grey: well preserved; light grey: poorly preserved elements; printed under a CC BY license, with permission from Julia Gresky, 2018.

https://doi.org/10.1371/journal.pone.0221171.g004
molars and premolars and are not in the anterior region where it might be rather related to biting or work-related activities [66].

Linear enamel hypoplasia are present on 13 of 21 teeth in a moderate expression (Grade II, [65]) (Fig 10). This condition represents a disturbance of enamel formation, which is attributed to periods of malnutrition or infectious disease during the developmental period of teeth (see e.g. [67]). Their occurrence can be related to the ages of 6±1 and 12 years [68].

Signs of interproximal grooving as straight shallow grooves with a semi-circular diameter are visible on the lingual half of the mesial surface (4x1mm) of tooth 27 (Fig 11), on the distal surface (5x1.2mm) (Fig 12A) and on the mesial surface (7x1mm) of tooth 26 (Fig 12B). Teeth 18, 28, and 36–38 do not show interproximal grooving, the other molars are too poorly preserved, the area of interest mainly missing.

Concentrations of fine roots and a possibly acid milieu in the grave caused the poor preservation of collagen. Both aDNA analysis on tooth (27) and stable isotope analysis of carbon and nitrogen failed because of these conditions. Strontium isotope ratios ($^{87}$Sr/$^{86}$Sr) (Table 4) were obtained from the lower right third molar (48) of the adult individual (Loc. C10:408; 0.70812) and from the lower left second molar (75) of a 3-4yrs old child (Loc. C10:405; 0.70811), who was buried in the same room in the south-eastern corner [56] (S1 Protocol). Both values are identical, even within the measurement error. This indicates that the adult and the child procured their food and drink from resources in the same habitats during enamel formation. Assuming that the child did not migrate in his/her short life, both individuals can be considered to be of a local origin. This is confirmed by two, almost identical, $^{87}$Sr/$^{86}$Sr ratios from
rock hyrax (Procavia capensis), a local medium-sized terrestrial mammal (Table 4). In comparison to published data from the wider area, the values from Ba’ja are at the lower range of the limestone formations of the Mount Carmel Area and Upper Galilee (0.7083–0.7086 [Kebara and Hayonim Cave]; [69]) and of the Basta individuals (0.7080–0.7082; [70]) (for the

Fig 7. Dorsal side of the left femur showing destruction by rodent gnawing. (Photo: JG).
https://doi.org/10.1371/journal.pone.0221171.g007

Fig 8. Atlas of the individual of Loc. C10:408. The left inferior apophyseal joint with small osteophyte of the rim (white arrow) and pitting of the surface (black arrow). (Photo: JG).
https://doi.org/10.1371/journal.pone.0221171.g008
geographic location of all mentioned sites see S1 and S2 Figs and S2 Table). At first, this seems unexpected, since the location of Ba’ja at the edge of Cambrian (541–485.4 mya), Ordovician (485.4–443.8 mya) and Cenomanian (99.6–93.6 mya) sandstone formations should have led to higher values than the younger Santonian-Turonian limestone area (about 94–83 mya) of Basta. However, the values corroborate earlier observations that there was no in situ supply of water close to the site. The next fossil water sources for Ba’ja are at about 1–5 km to the east in the Na’ur-Fuhays/Hummar/Shu’ayb Wadi as-Sir limestone formation. It is also possible that rainwater, which might have been stored in the siq, functioned as a water reservoir [3, 71]. It can be suggested that this was the local value of the area, indicating that the food and water supply regimes included the adjacent limestone formations. A systematic isotope survey for reference samples can clarify this issue.

**Grave goods**

The objects found in the grave can be divided in two main categories: items found inside the grave pit and objects embedded into the stone layer above the grave covering stone slabs (for all measurements see S1 Table).
Grave goods inside the grave. Around the left side of the head and on the chest of the individual were at least six isolated turquoise beads [72] and additional fragments of greenstone that may be amazonite (Fig 13). The beads were examined macro- and microscopically according to a use-wear approach [73–74]. They show use-wear traces all over the surfaces and with various stages of intensity: from moderately to heavily used and recycled items (Fig 14). A carnelian bead, shells and mother-of-pearl fragments were recovered from the sieved grave sediment.

On the left arm, the individual wore a composite upper arm ring made of one complete mother-of-pearl ring attached to four layers of marl (?) rings (Fig 15). On the right upper arm, he also wore a mother-of-pearl ring made of several pieces. Judging from the inner diameter of both rings (±70 mm), the buried person was not very corpulent, but rather gracile. The poor preservation of the human bone surfaces however precludes precise measurements.

The macehead next to the left shoulder was made of igneous rock. As mentioned above it was smashed in situ by a single high-energy blow (split in two halves with several fragments in situ; one fracture surface shows an impact point with radial scars) (Fig 16). Its height (53.0 mm) and weight (241.5 g) (see S1 Table) range at the upper end of Neolithic maceheads while the diameter (55.5 mm) is average [75]. A rather similar, but smaller and complete, item was discovered in the collective burial in area D (Table 5). Igneous rocks are not local. Between the fingers of the right hand, a red pigment mineral was found, but none of the bones showed clear red colouring, and the surrounding soil was not stained red either.

Fig 10. Tooth 23 with transversal enamel hypoplasia partly covered by calculus. (Photo: JG).
A complete pressure-flaked serrated bifacial flint dagger was found in the western part of the grave cover (Fig 17A). Low-powered use-wear analyses confirmed the impact burination at the tip and discovered rounding of the edges of the serration as well as an overall polish along all the edges and even on the middle of the blade. The impact burination at the tip and the slight rounding of the serrated edges (for 9.5 cm from the top on both sides) could indicate single penetration of an object in a stabbing
motion stopped by hard material (e.g. bone). The sharp unused serration at the base of the blade confirms that the dagger was definitely not used often as a cutting tool. The burination at the tip might have been caused by accidental or deliberate dropping on the floor. The

Table 4. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios measured on LPPNB human teeth and on animal bones and teeth from Ba’ja.

| Context/ID | Species | Age (yrs) | Sex | Tooth body part | Sample ID | $^{87}\text{Sr}/^{86}\text{Sr}$ | ±2 SD |
|------------|---------|-----------|-----|-----------------|-----------|----------------|-------|
| BJ16; Trench C10, Room CR 35, Loc. C10:405, double infant burial; Ind. II | human | 3–4 | indet | 75 | MA-172897 | 0.70811 | 0.00001 |
| BJ 16; Trench C10, Room CR 35, Loc. C10:408, adult burial | human | 25–35 | male ? | 48 | MA-172898 | 0.70812 | 0.00001 |
| Test Unit 2, 4126; BA’JA 4126_T_M | procavia capensis | | | tooth fragments | MA-190953 | 0.70815 | 0.00001 |
| C12, Loc C12:18 Fz. 4025; BAJA 4025_T_M | procavia capensis | | | tooth fragments | MA-190954 | 0.70814 | 0.00002 |
| C12, Loc C12:30 FN 4124; BAJA 4124_T_SC | equus africanus | | | bone | MA-190955 | 0.70829 | 0.00001 |

https://doi.org/10.1371/journal.pone.0221171.t004

Fig 13. Beads from grave Loc. C10:408. 1, 4–6: turquoise; 2: carnelian; 3, 10: fragments of greenstone (amazonite?); 7, 8: turquoise (?); 9: fragment of shell bead; 11–12: two fragments of Conus sp. (Scan: HGKG; modified by HA).

https://doi.org/10.1371/journal.pone.0221171.g013
uneven polish on many parts of the dagger may point to wrapping in a soft material or the use of such material during fabrication.

West of the dagger, a complete bone spatula and a cylindrical pestle of igneous rock were found. The pestle shows traces of use on its distal end. In the north-eastern part of the grave cover a rim fragment of a red sandstone bowl was uncovered. Furthermore, two flint projectile points of Byblos type were embedded in the cover (Fig 17B and 17C). Neither point exhibits any standard use-wear damage common on projectile points (e.g. diagnostic impact fracture or edge rounding), but they both have a broken tang caused by a snapping motion (which is very uncommon at the site).

The M.A.R.L. Cube v1

Synthesizing the different aspects of socio-neurobiological, anthropological and archaeological research outlined in the theoretical introduction, and the empirical data that will be discussed below, the following M.A.R.L.-Cube v1 is suggested to describe different forms of leadership.
within their social contexts (Fig 18). The abbreviation M.A.R.L. stands for the main aim of the model: modelling anthropological research on leadership, v1 stands for version 1 (for the catalogue of questions and calculations see S1 Text and Tables A–D in S1 Text).

Fig 15. Composite upper arm ring of Loc. C10:408. This unique object was made of one mother-of-pearl ring and four marl (?) rings. It was worn on the left upper arm. Republished from ex oriente e.V. under a CC BY license, with permission from Hans Georg K. Gebel, 2017.

https://doi.org/10.1371/journal.pone.0221171.g015

Fig 16. Deliberately broken macehead of igneous rock, Loc. C10:408. (Scan: HGKG).

https://doi.org/10.1371/journal.pone.0221171.g016
The M.A.R.L. Cube v1 respects the fact that the characteristic of the leader (1) is a crucial factor (z-axis: aggrandizer vs. primus inter pares). It also considers the relation of the social environment (2) to how power is achieved—either by self-motivated acclamation or by coercion—(x-axis: coercion vs. acclamation). And finally, (3) to whether communities are committed to a collective ethos with strong mutual relationships (y-axis: individualism vs. collectivism), i.e. that ideally the group’s need is more important than individual success, or to whether individualistic freedom is the ideal. With this three-dimensional model, communities

Table 5. Compilation of all burials of the LPPNB site of Ba’ja.

| ID/Location | Type | Number of Individuals | Sex | Position | Orient | CH | Red Pigment | MH | D | PP | BP | MOP arm ring | MOP amulet | Others | A | Reference |
|-------------|------|-----------------------|-----|----------|--------|----|-------------|----|----|----|----|-------------|-----------|--------|---|-----------|
| Loc. 26 Area D11/12/21/22 | C, 0.65 m², stone slab as grave cover (?) | 3 juvenile-adult 9 infants | mixed, indet | secondary | ? | X | X on bones and objects | 1 | 1 | 9 | “plenty” | 0 | 1a, 1b | 0 | 0 | [58, 71] |
| Loc. C10:170/133, CR 34 Area C10 | C, suprafloor, room as grave | 2 infants II, 4 adult | 1 female 3 male 2 infants | indet | secondary | 1 skull facing east | Very few | X | 1 piece | 0 | 0 | 12 | 0 | 0 | 0 | 0 | X | [59] |
| Loc. C10:152, CR 35 Area C10 | C, 80x70 cm Pit, stone slab as grave cover | 2–3 adults, 1 juvenile 3–4 children (1 newborn) | 1 male 1–2 adult | indet | Infants | ? | ? | X on bones and grinding stone, pieces | 0 | 1 | 4 | >19 | 0 | 0 | Grindstones with red pigment, sandstone ring fragment, greenish pigment | 0 | [59] |
| Loc. C10:408, CR 35 Area C10 | S, c. 1m², cist grave, several coverings | 1 young adult (25–35) | male | crouched, left side | SW-NE | Few | X | 1 piece | 1 | 1 | 2 | >8 | 2 | 0 | Pestle, stone vessel fragment, bone spatula | 0 | [56] |
| Loc. C10:405, CR 35 Area C10 | Db, small round pit, c. 0,2 m² | 2 infants I | 1 female (a-DNA) | indet | sitting/squatting | W-E, E-W, facing each other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [56] |
| Loc. C1:44/46, CR 36.1, Area C1 | S, cist grave, c. 1m², several coverings | 1 infants II | Female | crouched left side | E-W | Few | X | bones complete, 1 piece | 0 | 0 | 0 | >2500 | 0 | 1a | 3 grinding stones with pigment, 1 red stained stone plate | 0 | This study |
| Loc. 5, TU 7, Area A | S, without grave pit, in rubble layer | 1 adult 25–50 yrs | female | crouched, left, on back | N-S, facing S | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | [59] |

Type: C = collective, M = multiple, Db = double; S = single; Orient = orientation; CH = charcoal
Grave goods: MH = macehead, D = dagger, PP = projectile point, BP = beads and pendants, MOP = mother-of-pearl (a = with pierced appendices, b = without appendices), A = animal bones
†intentionally broken
‡ combined with 4 marl arm rings
‡ with burination; the burials are listed according to their location from north to south.

https://doi.org/10.1371/journal.pone.0221171.t005
can be localized in an area of probability even when some information is missing. Moreover, it allows the tracking of the development of a community from one area to another.

The three main factors: 1) leading agency 2) pathways to power and 3) socio-political ethos are studied according to the standardized questionnaire (S1 Text). For every factor, several
subcriteria are studied and an estimated value is attributed on a scale between -1 and 1 in steps of 0.25 for every subcriterion, all of the latter are weighted equally. The calculated index is the median of all estimations for each factor. The mean absolute deviation from the median is indicated by the error bars. The median values of the main factors determine the position on the x-, y- and z-axis of the M.A.R.L. Cube v1. This comprehensive analysis should be considered as a first step in systematizing studies on emerging leadership. The application of the questionnaire to several case studies will allow a comparison of past and present forms of leadership systematically, despite the wide range of temporal and regional peculiarities. Since in prehistoric archaeology the only empirical data are physical remains, ethos can serve only as an indirect criterion. Aspects of material culture must be defined as evidence for ideas or social behaviors. The combination of material remains, anthropological data and imagery might allow a differentiation between represented ideas and daily practices in a qualitative investigation of the data (for such a multilevel approach see [77]).

The M.A.R.L. Cube v1 should be considered work in progress. It will prove to have its weaknesses and strength with further test cases and will probably require adjustments and refinements. It does not imply any evolutionary teleological tracks, but should promote a holistic understanding of different forms of leadership and of pathways to power.

Discussion

In the following section the empirical data are discussed according to the three main categories elaborated in the M.A.R.L. Cube v1 (see above). The grave construction, the burial ritual and the grave goods have demonstrated that the buried person must have been outstanding in many respects [56] (Table 5). For an in-depth description of the various categories see S1 Text. The space “occupied” by the single burial is almost identical to collective graves of the site. Its location and construction differs little from other graves of the site following a more ancient
An outstanding burial from the Late Pre-Pottery Neolithic site of Ba'ja, southern Jordan

Characteristics of the outstanding person (S1 Text, Tables A and B in S1 Text, S1 Table)

The burial ritual as well as the objects found inside the grave and in the grave cover provide important information about the social identity of the buried person. The size and shape of the bifacial dagger resembles the two daggers discovered at Ba'ja in the adjacent collective Burial Loc. C10:152 and in the collective Burial Loc. 26 in D11/12/21/22 [58–59]. A medial fragment of a fourth item was found in the room fill above the grave in Area D. A similar dagger fragment comes from the LPPNB site of Basta. All daggers are of non-local raw-material and were obviously not produced at Ba'ja, but rather probably in the south-eastern present-day arid steppes of Jordan or in the Negev. The lack of waste for the production of such daggers at Ba'ja underlines the exotic character of this object [81]. A very similar burination on the tip of the blade has been observed on the dagger of the Grave Loc. 26 in Area D. It thus seems possible, that the burination was a deliberate action related to the burial ritual as some kind of devaluation of the object. However, the dagger of the collective Burial Loc. C10:152 had not been destroyed.

The damage to the dagger from Loc. C10:408 parallels the deliberate destruction of the macehead and the projectile points. The position and type of fracture indicate that the projectile points were intentionally broken from the shaft of the arrows. These damages and the lack of characteristic use-wear traces suggest that the points were not used in daily life. The location of the projectile points and the dagger in the grave cover, in contrast to the macehead, might point to a different meaning. Maceheads are rare during the LPPNB. Beside the above-mentioned item of the collective burial of Area D from Ba'ja, a single basalt macehead has been reported from LPPNB layer of 'Ain Ghazal [82]. However, they become more common during the Pottery Neolithic and Chalcolithic. Most of them were made of various types of limestones, basalt being exceptional. Many of them were broken in two halves and only a few were discovered in graves [75, 83].

All three items—the projectile points, the dagger and the macehead—are potential weapons and might have characterized the person as a hunter or warrior. They could also have been laden with a purely symbolic meaning related to social status. During later periods, maceheads became classical symbols of status, but whether this meaning can be transferred to the Pre-Pottery Neolithic remains an open question. Irrespective of their precise meaning, it seems that...
the power displayed by these items should be terminated after death. The microscopic use-
wear traces on the dagger and the regular connection of daggers with burial contexts at Ba’ja
suggest that these rare objects were possibly exclusively used in burial rituals or as symbols of
status.

The above-mentioned composite upper arm ring is unique so far (Fig 16). The mother-of-
pearl ring of the right upper arm was composed of several parts. Both items were so fragile that
it is hardly possible that they were worn during daily life, but they probably represented high
status or prestige objects worn during lifetime at special occasions or offered after death.

The material of the beads corresponds to the increasing use of stone beads in general [73],
and especially green-stones during the PPN [84–89], a trend that had already started during
the Natufian [69, 90–94]. Turquoise and carnelian are exotic to the site. Raw material sources
of turquoise are known in the Negev and Sinai [85]. The closest sources of carnelian were
recorded in the Negev, Sinai and western Saudi-Arabia [93]. Carnelian bead production on a
large scale at the oasis of Tayma in north-western Saudi-Arabia during later periods hints at
close raw material sources as well [94]. If the raw-material determination of amazonite were
confirmed, it would point to the Hisma in south-eastern Jordan [95]. Microscopic analyses of
the beads showed that they were in use for a longer period of time. The homogenous distribu-
tion of the use-wear traces all over the surfaces indicates that they were enchained rather than
fixed on clothes or other support. Whether they were offered by people participating in the
funeral or whether they were personal items, remains an open question, but the position
around the neck speaks in favour of the latter option. The handling of the beads over a long
time and the recycling, points to the importance and value of these items. However, except for
the upper arm rings, all the other objects were not exclusive to this burial, i.e. access to the
raw-material or to the finished products, was not restricted to certain inhabitants of the settle-
ment. Compared to the recently discovered child burial (Loc. C1:44/46) the number of beads
even seems to be rather low.

The body’s position recalls the crouched position of one of the upper skeletons of the collec-
tive Burial Loc. C10:152 and the burial from the midden context TU 7, Loc. 5 [59] as well as
the above-mentioned child burial in the southerly adjacent room CR 36.1 at Ba’ja. Interest-
ingly, neither the skull nor any other body part had been removed. This trait strongly differenti-
tiates the adult individual in Loc. C10:408 from the collective burials at Ba’ja and also from
many other individual or collective burials where fragmentation, segregation and re-deposi-
tion of isolated bones or body parts seemed to be common ([46, 96–97], see also [17]). The
identity of this individual should not be merged with a “collective body of ancestors” (p. 188–
189) [46].

Furthermore, the small diameter of the composite upper-arm ring, if worn during life, hints
at a very gracile person. This physical trait might underline the special position, especially in
an early farming community, where daily work-load probably required physical strength [98].
However, a preliminary notion on the late PPNB population of Basta suggested a “relatively
gracile typus” too [79]. Only further analyses of all individuals from Ba’ja and the results of the
detailed analyses of the Basta individuals will show whether gracility is a typical trait of the
local population. A preliminary analysis of the children of Burial Loc. C10:405 suggests rather
robust body constitution. Transverse linear enamel hypoplasia indicates periods of stress (e.g.
malnutrition or infections) during childhood, and might contradict ascription of a special sta-
tus due to birth. However, hypoplasia is common in Neolithic communities [96–97] and
might also evidence children whose immune system was efficient enough to survive these peri-
ods of stress. The chipping of enamel on some teeth hints at the consumption of very hard
material, perhaps pistachio nuts or almonds. Rather weak attrition of the molars and the lack
of caries contradict increased consumption of a diet rich in ground cereals, cf. [99]; very few
incidences of caries (2 of 22) were also observed at Basta [96]. Interproximal grooves on two of
the molars might hint at cleaning teeth with a thin stick made of bone or wood. Whether the
differential wear of frontal and posterior teeth reflects a working task exclusive to this person
or characterizes the habit of a special group has to await the analyses of the whole corpus of
individuals. Neither chipping nor interproximal grooving has been reported from former
investigations at Basta or Ba’ja [96]. The results of the strontium isotope analysis suggest that
the buried person lived directly at or close to the Neolithic site of Ba’ja.

To sum up, empirical data for the character of the outstanding person tend to speak in
favor of a possibly local, corporate prototypical leader, who was clearly displayed after death as
a member of the local community following the structure of common collective burials. The
material objects, burial ritual and grave construction tend more to a representation as primus
inter pares. However, the reclaimed space, the efforts in grave construction, the single burial,
and the display of exotic personal items inside the grave reduce the median of all sub-catego-
ries from a purely primus inter pares type (= 1) towards the aggrandizer type with a median of
all subcategories at 0.38±0.17. The distinct spatial segregation suggests that he should be
remembered as an individual in the collective memory.

Achieving excellence: Acclamation vs. coercion (S1 Text, Table C in S1
Text)

Achieving supra-regional power by physical coercion has been suggested as a prime mover for
establishing chiefdoms [6]. Empirical data from the early Neolithic of the Near East has been
interpreted in both directions: absence or presence of supra-communal conflicts (e.g. [100] vs.
[19]). No evidence of physical force has yet been observed on the individuals from Ba’ja. How-
ever, skull traumata and one lethal injury were reported from other contemporary sites: Basta
(5 of 29 individuals; [96]), Wadi Shu’eib (3 of 17 individuals; [101]) and ‘Ain Ghazal (1 of 7
individuals, [82]). An in-depth discussion of the possible reasons for these injuries (interper-
sonal conflicts, accidents, intra- or inter-group conflicts, or both?) is out of the scope of this
paper. However, physical force is only one aspect of human aggression. A lack of evidence for
injuries does not exclude subtle means of suppression such as social or economic deprivation.

There is no imagery showing the position or social role of the individual, but both catego-
ries of grave goods comprise potential weapons. All of these items were deliberately destroyed
or showed damage which meant at least a partial loss of value. The micro-traces of the dagger
indicate that it was made for status, representation or ritual rather than for daily use. As sug-
gested by Gebel [3] there is no clear evidence for “(aggressive) institutional forces”.

With the burial of that person, his power should be terminated too. Prestige or status sym-
boles were deliberately destroyed and not transferred to a successor (for a similar praxis see
[102]). As mentioned above, the hermetic sealing of the grave also hints at an effort to termi-
nate or control the possible (dangerous) power of the deceased [18]. This might suggest that
the outstanding position was acquired through personal skills or properties rather than by her-
itable institutionalized succession. Future aDNA analyses might help to solve the question
whether status was due to familial succession but, for now, there is no sign of ascription of an
outstanding status due to birth.

Furthermore, the individual was buried shortly after death, given that most of the bones
were still in an anatomically correct position. Drying by mummification cannot be excluded,
but the lack of gnawing traces from carnivores means that it is improbable that the body was
laid out for drying. In contrast to other early Neolithic sites of Basta and Göbekli Tepe [97,
103], no cut marks have been observed, but they might partly be obliterated by poor preserva-
tion of the bones’ surface. Whether the shallow white monticule formed by the grave served as
a point of reference or memory is unclear. The physical presence of this person after death was
definitely less significant than of selected persons of other MPPNB and LPPNB sites, whose
skulls were retrieved after death, plastered and exhibited for some time. Even after reburial,
groups of skulls served as points of reference [104–107]; for a recent summary on that topic
see [31] vs [36]). This difference can be interpreted in two directions: prestige had been
acquired due to personal traits of behaviour and ended with death; or the individual only
played an ascribed role during life-time in an institutionalized rank-system, being replaced
after death by someone else, i.e. his function within society made him outstanding. Taking
into account the evidence from the grave goods, which were neither exclusively used, nor
given over to a successor but destroyed, the first interpretation of acquired prestige or status
seems more probable. However, the on-going studies of the above-mentioned lavishly deco-
rated child burial Loc. C1:44/46 may require reconsidering these conclusions in the future.
Not a single fragment of the otherwise ubiquitous sandstone rings was found in the burial
Loc. C10:408, clearly separating “economic” commodities from other rare (prestige) objects
[26, 108]. Only in the adjacent collective burial Loc. C10:152 was a fragment of a sandstone
ring discovered [59]. It can thus be suggested that it was not the accumulation of economic
wealth that contributed to the high ranking position of this individual; at least, during burial
ritual, the displayed ideology did not aim to demonstrate accumulated wealth but rather rare,
highly symbolically laden objects. The decoration with exotic beads (or the giving of beads)
should probably indicate access to, if not active participation in, a supra-regional exchange
network [109]. The different intensity of use of the beads might indicate that their exchange
was used to signal and possibly reinforce social relationships. In contrast to the nearby sites of
Shkārat Msaied [89], Beidha [110] and specialized amazonite workshops in the Hisma [95], no
bead workshop has yet been identified at Ba’ja and micro-drills are very rare at the site [81].
However, the unfinished perforation of some beads, fragments of greenstone beads, and pieces
of carnelian raw material might evidence some local production.
The supra-regional–possibly down-the-line–exchange networks represent very old relations
from the Red Sea to the northern Levant [73–74, 109, 111]. Non-local raw materials indicate
exchange with eastern modern-day steppe areas, the Negev and Sinai and possibly western
Arabia. The origin of igneous rock has not yet been determined. Whereas shells were
exchanged in large quantities, green stone and carnelian beads represented rare items, even
during the PPN [73, 85–86, 89, 112]. During the LPPNB, non-local flints declined consider-
ably. This might hint at reduced access to these exchange networks [81] or shifted acquisition
patterns for flint raw materials. Although access to exotic objects was not confined to one indi-
vidual or group and although the spectrum of exotic materials increased, the general trend of
reduced non-local raw materials might have contributed to enhancing prestige of those who
still had access to these networks [81].
Though most of the recorded items seem to be of profane use, it cannot be excluded that
some of them were especially produced for a funeral function with a special ritual meaning.
The few use-wear traces on the dagger and the fragility of the arm rings might point in that
direction, but it seems premature to decide on “religious” or profane status of the individual,
cf. [4].
Considering the evidence of access to power, clear evidence for physical coercion is lacking.
It seems probable that excellence was attributed as a result of personal behavior or traits. Any
conclusion about the importance of familial relationships remains highly speculative since
information on genetic relations is mainly lacking. Only further anthropological analyses
might clarify familial relationships between the lavishly decorated burials in Area C and the
other collective burials. The median value for the analyzed data ranges at 1 ± 0.35 showing a
strong tendency to acclamation or ascription of a social position rather than achieving power by coercion.

**Ethos of the community: Individualistic vs. Collective (S1 Text, Table D in S1 Text)**

Generally, the community of Ba'ja seems to be rather homogenous, yet without strict canonization. At least during its final occupation, the agglutinated rooms appear as one confined entity bordered by the deep gorges of the siq. Despite complex use biographies and constant changes in spatial layout, domestic buildings did not differ categorically from one and another [71, 113–114]. Walls were so close to each other that daily life probably became a challenge. So far, neither special or communal buildings nor communal monuments have been discovered. Except for the parallel walls that were sloping in north-south direction on the southern slope of the settlement in Area F [71], no terracing like that of Basta [115] has been recorded so far.

The distribution of objects seems to be rather homogeneous, too, so that the production of sandstone rings has even been termed “community specialization”. Nonetheless, some groups seem to have had access to better flint resources and were more skilled in flint production [81].

In the three collective burials of Areas C and D, individualism was annihilated and individuals (if they have been conceived at all as this) were merged into groups of dead. The contrast between collective and single burials might parallel the development observed in the central and southern Levant from a group-oriented ideal to the veneration of single adult individuals [4, 43, 116–117]. However, it is not only in the ritual sphere that increasing segregation is observed. Also in economic and social relations, relational corporate identities seem to dissolve due to increasing specialization [19].

Evidence for doctrinal canonized symbolism is lacking in the southern Levant which is in strong contrast to Northern Mesopotamia [19, 37, 53, 117]. In daily practice things were repeatedly done in the same manner. For example, sandstone rings that were produced en masse at Ba'ja followed a general idea and had a standardized chaîne opératoire, despite some variation in size and style. Similarly, burial rituals adhered to a general pattern of grave construction, but not one grave is identical to the other. For now, only two types of objects have been identified as highly standardized: the daggers and the mother-of-pearl ring spacers for small children [26, 58, 118–119]. Both items seem to convey certain identities.

It has to be emphasised that this broad outline still lacks meta-analyses of anthropological data. Even though many burials have been excavated in the southern Levant, a comparison of kinship, e.g. [70, 120], health status, mobility or diet on the basis of anthropological data has to await future research. Any conclusion about genetic relationships concerning social differentiation, such as inheritance, “lineages” or even “tribes” or “clans” remains highly speculative.

Whereas the median of the material records from the settlement and architecture show no clear trend (0.0±0.42), the display of boundaries mirrors a strong collective identity (0.75±0.25). The term corporate sensu Gebel [19] is avoided here since it implies confined corporate identities, which is not necessarily the case in the opposition between individualistic and collective ethos. Overall, the values for the group ethos tend to the collective side (0.25±0.25).

**Conclusion**

The summary of the results of the systematic analyses allows us to conclude that the individual buried in Loc. C10:408 was probably a local, outstanding person represented after death according to the structurally same burial ritual as other group members, but definitely set apart from the ordinary by the elaboration of the grave construction and the presence of exotic and technically sophisticated objects and materials (Fig 18). This individual was interred and
kept in the collective memory *sensu* Assmann [121] as *primus inter pares* using structurally the same burial rituals and colour symbolism as in other graves. The deliberate destruction of symbolic grave goods of physical force hints at the termination of achieved prestige or status rather than an inherited status. The segregation from the other collective burials and the occupation of space similar to group burials point to an outstanding authority. This is in line with the suggested development from corporate identities during the middle PPNB to the increasingly extraordinary status of single individuals during the LPPNB ([116, 53]; see also [4, 43, 46]). The ongoing research on “Household and Death” at Ba’ja [56] will possibly clarify whether the emulation of “the general corporate identity regime [had] started with ‘sub- or peer-identities’ becoming ‘non-corporate’” (p.70) [19].

For the LPPNB of Ba’ja, we suggest that single individuals achieved prestige or status or both on the one hand by their access to exotic items, probably through ancient networks of equally influential persons in other communities of the southern Levant. They still had access to exotic items even though there was an overall reduction of imported material [81]. They were possibly the beneficiaries of increasing territorialism [3, 53] as intergroup conflicts might have enhanced their authority as leaders [3, 20].

On the other hand, he sought support in his local group by prototypicality, which is a characteristic of group-oriented chiefdoms [22] and of relational communities [19]. The position of the grave reflects this tension in a similar way: It was spatially segregated, but in the same room as the collective burial Loc. C10:152 and the double infant burial Loc. C10:405 [56]; close proximity to other group members should be maintained.

The outstanding person from Ba’ja thus incorporates elements of both types of leaders—corporate and individualistic—in an otherwise increasingly heterarchical community. Neither a costly display of accumulated things nor a display of physical strength played a decisive role in the burial ritual; other criteria, such as personal skills, behaviour, or traits, must have been decisive. Future anthropological investigations will possibly help to refine our understanding of the reasons for the social segregation and excellence of this individual.

**Supporting information**

S1 Table. List of grave goods of Loc. C10:408.

(DOCX)

S2 Table. Means of $^{87}$Sr/$^{86}$Sr-isotope ratios from different locations in the Levant (from south to north).

(DOCX)

S1 Fig. Geological setting of major Pre-Pottery Neolithic B sites in southern Jordan. Map designed by C. Purschwitz based on compilation of data from [122–128]; printed under CC BY license, with permission from C. Purschwitz, 2019.

(TIF)

S2 Fig. Comparison of $^{87}$Sr/$^{86}$Sr-isotope ratios from Ba’ja with data from other geological settings in the Levant. Plain diamonds represent means; error bars represent the 95% confidence interval for each site. Red: samples from Ba’ja analyzed in this text; pinkish: (Pre-)Cambrian sandstones and granitic formations of Wadi Rum; blue/green: limestone formations southeast of Ba’ja / in the Mount Carmel Area and Upper Galilee; orange: Quaternary basalts and limestones; brown: travertine deposits. Data sources: [69–70, 129–130]. (Graph: MB/CK).

(TIF)
S3 Fig. Probability ranges of calibrated radiocarbon dates.
(PDF)

S1 Text. Analytical questionnaire for the Burial Loc. C10:408.
(DOCX)

S1 Protocol. Sample preparation for strontium isotope analyses.
(DOCX)

Acknowledgments
We are grateful to Monther Jamhawi, then director-general of the Department of Antiquities in Jordan and Aktham Oweidi, director of excavations at the DoA, who provided excellent support for our research. Thanks are also due to Dominik Bonatz for his support, Pauline H. King for the language editing and to Katie Tucker who shared the anthropological work of the season and partly excavated the Burial Loc. C10:408 as well as Reinder Neef for the identification of the charcoal samples. We also thank all team members and devoted workmen of the 2016 season at Ba’ja.

Author Contributions
Conceptualization: Marion Benz, Joachim Bauer.
Data curation: Marion Benz.
Formal analysis: Julia Gresky, Corina Knipper.
Funding acquisition: Marion Benz, Christoph Purschwitz, Hans Georg K. Gebel.
Investigation: Marion Benz, Julia Gresky, Denis Štefanisko, Hala Alarashi, Hans Georg K. Gebel.
Methodology: Marion Benz, Denis Štefanisko, Hala Alarashi.
Project administration: Christoph Purschwitz, Hans Georg K. Gebel.
Supervision: Hans Georg K. Gebel.
Visualization: Marion Benz, Hala Alarashi, Corina Knipper, Christoph Purschwitz, Joachim Bauer, Hans Georg K. Gebel.
Writing – original draft: Marion Benz, Julia Gresky, Denis Štefanisko, Hala Alarashi, Corina Knipper, Joachim Bauer.
Writing – review & editing: Marion Benz, Julia Gresky, Corina Knipper, Christoph Purschwitz, Joachim Bauer, Hans Georg K. Gebel.

References
1. Renfrew C. Space, time and polity. In: Rowlands M, Friedman J, editors. The evolution of social systems. London: Duckworth; 1974. pp. 89–114.
2. Price TD, Feinman GM, editors. Pathways to power. New perspectives on the emergence of social inequality. Fundamental Issues in Archaeology. New York: Springer; 2012.
3. Gebel HGK. Central to what? The centrality issue of the late PPNB megasite phenomenon in Jordan. In: Bienert H-D, Gebel HGK, Neef R, editors. Central settlements in Neolithic Jordan. Studies in Early Near Eastern Production, Subsistence, and Environment 5. Berlin: ex oriente; 2004. pp. 1–19.
4. Rollefson GO. The character of LPPNB social organization. In: Bienert H-D, Gebel HGK, Neef R, editors. Central settlements in Neolithic Jordan. Studies in Early Near Eastern Production, Subsistence, and Environment 5. Berlin: ex oriente; 2004. pp. 145–155.
5. Chacon RJ, Mendoza RG, editors. Feast, famine or fighting? Multiple pathways to social complexity. New York: Springer; 2017.

6. Carneiro RL. The chiefdom in evolutionary perspective. In: Carneiro RL, Grinin LE, Korotayev AV, editors. Chiefdoms yesterday and today. Clinton Corners: Eliot Werner Publications; 2017. pp. 15–62.

7. von Rueden C, Alami S, Kaplan H, Gurven M. Sex differences in political leadership in an egalitarian society. Evol Hum Behav 2018; 39(4): 402–411. https://doi.org/10.1016/j.evolhumanbehav.2018.03.005 PMID: 30319239

8. Fried MH. The evolution of political society: an essay in political anthropology. New York: Random House; 1967.

9. Hansen RD. The feast before famine and fighting: the origins and consequences of social complexity in the Mirador Basin, Guatemala. In: Chacon RJ, Mendoza RG, editors. Feast, famine or fighting? Multiple pathways to social complexity. New York: Springer; 2017. pp. 305–335.

10. Yi J. Highly stratified societies without permanent leadership: the Yi in Liangshan of southwestern China. In: Chacon RJ, Mendoza RG, editors. Feast, famine or fighting? Multiple pathways to social complexity. New York: Springer; 2017. pp. 133–164.

11. Hayden B. The power of feasts. From prehistory to the present. Cambridge: Cambridge University Press; 2014.

12. Kim NC. Coercive power and state formation in Northern Vietnam. In: Chacon RJ, Mendoza RG, editors. Feast, famine or fighting? Multiple pathways to social complexity. New York: Springer; 2017. pp. 165–196.

13. Claessen HJM, van de Velde P. Social evolution. In: Claessen HJM, van de Velde P, Smith ME, editors. Development and decline. South Hadley: Bergin and Garvey; 1985. pp. 246–263.

14. Feinman GM. Multiple pathways to large-scale human cooperative networks: a reframing. In: Chacon RJ, Mendoza RG, editors. Feast, famine or fighting? Multiple pathways to social complexity. New York: Springer; 2017. pp. 459–478.

15. Vivelo FR. Handbuch der Kulturanthropologie. München: Klett-Cotta; 1988.

16. Roscoe P. The emergence of sociopolitical complexity: evidence from contact-era New Guinea. In: Chacon RJ, Mendoza RG, editors. Feast, famine or fighting? Multiple pathways to social complexity. New York: Springer; 2017. pp. 197–222.

17. Stanish C. The evolution of chiefdoms. An economic anthropological Model. In: Feinman GM, Nicholas LM, editors. Archaeological perspectives on political economies. Salt Lake City: University of Utah Press; 2004. pp. 7–24.

18. Wengrow D. Farewell to the ‘childhood of man’: ritual, seasonality, and the origins of inequality. J Roy Anthropol Inst (N.S.) 21: 597–619.

19. Gebel HGK. Neolithic corporate identities in the Near East. In: Benz M, Gebel HGK, Watkins T, editors. Neolithic corporate identities. Studies in Early Near Eastern Production, Subsistence, and Environment 20. Berlin: ex oriente; 2017. pp. 73–104.

20. Hogg MA. A social identity theory of leadership. In: Vohs KD, Baumeister RF, editors. Self identity III: interpretational self. Los Angeles: Sage; 2012. pp. 9–35.

21. von Rueden C, Gurven M, Kaplan H, Stiglitz J. Leadership in an egalitarian society. Hum Nature 2014; 25(4): 538–66. https://doi.org/10.1007/s12110-014-9213-4 PMID: 25240393

22. Feinman GM. A dual-processual perspective on the power and inequality in the contemporary United States: framing political economy for the present and the past. In: Price TD, Feinman G, editors. Pathways to power. New perspectives on the emergence of social inequality. Fundamental issues in archaeology. New York: Springer; 2012. pp. 255–288.

23. Price TD, Feinman GM, editors. Foundations of social inequality. New York: Plenum Press.

24. Imbusch P. Macht und Herrschaft in der wissenschaftlichen Kontroverse. In: Imbusch P, editor. Macht und Herrschaft. Sozialwissenschaftliche Theorien und Konzeptionen. Wiesbaden: Springer; 2012. pp. 9–35.

25. Fairhurst GT, Grant D. The social construction of leadership: a sailing guide. Manage Commun Q 2010; 24(2): 171–210.

26. Gebel HGK. Commodification and the formation of early Neolithic social identity. The issues as seen from the southern Jordanian Highlands. In: Benz M, editor. The principle of sharing. Segregation and construction of social identities at the transition from foraging to farming. Studies in Early Near Eastern Production, Subsistence, and Environment 14. Berlin: ex oriente; 2010. pp. 35–80.

27. Makowsky MD, Smaldino PE. Evolution of power and the divergence of cooperative norms. J Econ Behav Organ 2016; 126: 75–88.
28. Gebel HGK. Subsisten zformen, Siedlungsw eisen und Prozesse des sozialen Wandels vom akera- 
mischen bis zum keramischen Neolithikum [dissertation]. Freiburg: University library; 2002. Availab 
le from: http://www.freidok.uni-freiburg.de/volltexte/466.

29. Price TD, Bar-Yosef O. Traces of inequality at the origins of agriculture in the Ancient Near East. In: 
Price TD, Feinman G, editors. Pathways to power. New perspectives on the emergence of social 
inequality. New York: Springer; 2012. pp. 147–168.

30. Bar-Yosef O. Was Göbekli Tepe culture a chieftdom that failed? In: Finlayson B, Makarewicz C, edi 
tors. Settlements, survey, and stone. Essays on Near Eastern prehistory in honour of Gary Rollefson. 
Berlin: ex oriente; 2014. pp. 159–168.

31. Garfinkel Y. The life cycle of Pre-Pottery Neolithic B plastered skulls from the Southern Levant. In: Fin 
layson B, Makarewicz C, editors. Settlements, survey, and stone. Essays on Near Eastern prehistory 
in honour of Gary Rollefson. Berlin: ex oriente; 2014. pp. 145–158.

32. Goring-Morris AN. 2000. The quick and the dead. The social context of aceramic Neolithic mortuary 
practices as seen from Kfar HaHoresh. In: Kuijt I, editor. Life in Neolithic farming communities. Social 
analyse, identity, and differentiation. New York [etc.]: Kluwer Academic, Plenum Publishers; 2000. pp. 103–136.

33. Dunbar RIM, Gamble C, Gowlett J. The social brain and the distributed mind. P Brit Acad 2010; 158: 
3–15.

34. Hodder I, Cessford C. Daily practice and social memory at Çatalhöyük. American Antiquity 2004; 69 
(1): 17–40. https://doi.org/10.2307/4128346

35. Byrd B. Reassessing the emergence of village life in the Near East. J Archaeol Res 2004; 69 
(1): 17–40. https://doi.org/10.1007/s10814-005-3107-2

36. Kuijt I. The regeneration of life. Neolithic structures of symbolic remembering and forgetting. CA 2008; 
49(2): 171–197.

37. Benz M, Bauer J. Symbols of power—symbols of crisis? A psycho-social approach to Early Neolithic 
symbol systems. Neo-Lithics 2013; 13(2): 11–24.

38. Wiessner P. The vines of complexity. CA 2002; 43: 233–269.

39. Lamberg-Karlawsky CC. Labor, social formation, and the Neolithic Revolution. In: Steinkeller P, Hud 
son M, editors. Labor in the ancient world. The international scholars conference on ancient Near Eastern 
economies 5. Dresden: Islet; 2015. pp. 37–68.

40. Benz M. Die Neolithisierung im Vorderen Orient. Theorien, archa 
obische Daten und ein ethnolo 
gisches Modell. Neo-Lithics 2013; 13(2): 11–24.

41. Rollefson GO. “I am We”: The display of socioec onomic politics of Neolithic commodification. In: Benz 
M, editor. The principle of sharing. Segregat ion and construction of social identities at the transition from foraging to farming. Studies in Early Near Eastern Production, Subsistence, and Environment 14. Berlin: ex oriente; 2010. pp. 182–202.

42. Röhrer-Ertl O. Die Neolithische Revolution im Vorderen Orient. München, Wien: R. Oldenburg Ver 
lag; 1978.

43. Hermanssen BD. Death, feasting, and memory culture at early Neolithic Shkärat Msaied, southern Jor 
dan. In: Delage C, editor. The last hunter-gatherer societies in the Near East. BAR, International Series 1320. Oxford: Hadrian Books; 2004. pp. 263–308.

44. Rollefson GO. I am We. The display of socioeconomic politics of Neolithic comodification. In: Benz 
M, Gebel HGK, Watkins T, editors. Neolithic corporate identities. Studies in Early Near Eastern Pro 
duction, Subsistence, and Environment 20. Berlin: ex oriente; 2017. pp. 107–116.

45. Rollefson GO. Blood loss: realignm ents in community social structures during the LPPNB of Highland 
Jordan. In: Benz M, editor. The principle of sharing. Segregation and construction of social identities at the transition from foraging to farming. Studies in Early Near Eastern Production, Subsistence, and Environment 14. Berlin: ex oriente; 2010. pp. 182–202.

46. Özdoğan M. The quest for new criteria in defining the emergence and the dispersal of Neolithic way of 
life. In: Manen C, Perrin T, Guilaine J, editors. La transition néolithique en Méditerranée. Aix en Pro 
vice: Errance; 2014. pp. 74–90.

47. Kuijt I. New perspectives on old territories: ritual practices and the emergence of social complexity in the Levantine Neolithic. UMI Microform; 1996.

48. Goring-Morris AN, Belfer-Cohen A. A roof over one’s head: Developments in Near Eastern residential 
arquitecture across the Eppiplaeeolithc–Neolithic transition. In: Bocquet-Appel JP, Bar-Yosef O,
editors. The Neolithic demographic transition and its consequences. Dortrecht, London: Springer; 2008. pp. 239–286.

50. Hodder I. The leopard’s tale. Revealing the mysteries of Çatalhöyük. New York: Thames and Hudson; 2006.

51. Rollefson GO. Ritual and social structure at Neolithic ‘Ain Ghazal. In: Kuijt I, editor. Life in Neolithic farming communities. Social organization, identity, and differentiation. New York [etc.]: Kluwer Academic, Plenum Publishers; 2000. pp. 165–190.

52. Willer D, Emanuelsen P, Chacon Y, Chacon RJ. How chiefdom and early state social structures resolve collective action problems. In: Chacon RJ, Mendoza RG, editors. Feast, famine or fighting? Multiple pathways to social complexity. New York: Springer; 2017. pp. 417–452.

53. Gebel HGK. The territoriality of Early Neolithic symbols and ideology. Neo-Lithics 2013; 13(2): 39–41.

54. Whitehouse H. Modes of religiosity. Walnut Creek (CA): AltaMira Press; 2004.

55. For all excavation reports see www.exoriente.org/baja.

56. Gebel HGK, Benz M, Porschitz C, Kubiková B, Štefanisko D, al-Souliman AS, et al. Household and death: Preliminary results of the 11th Season (2016) at Late PPNB Ba’ja, Southern Jordan. Neo-Lithics 2017; 17(1): 19–36.

57. Gebel HGK, Hermansen BD. Ba’ja 2003: summary on the 5th season of excavation. Neo-Lithics 2004; 04(2): 15–18.

58. Gebel HGK, Hermansen BD. LPPNB Ba’ja 2001. A short note. Neo-Lithics 2001; 01(2): 15–20.

59. Gebel HGK, Hermansen BD, Kinzel M. Ba’ja 2005: A two-storied building and collective burials. Results of the 6th season of excavation. Neo-Lithics 2006; 06(1): 12–19.

60. Bronk Ramsey C. Methods for summarizing radiocarbon datasets. Radiocarbon 2017; 59(2): 1809–1833.

61. Reimer PJ, Bard E, Bayliss A, Beck JW, Blackwell PG, Bronk Ramsey C et al. Intcal 13 and Marine 13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 2013; 55(4): 1869–1887.

62. Buikstra JE, Ubelaker DH, editors. Standards for data collection from human skeletal remains. Archeological Survey Research Series 44. Arkansas: Fayetteville; 1994.

63. Brothwell DR. Digging up bones: the excavation, treatment, and study of human skeletal remains. Ithaca: Cornell University Press; 1981.

64. Nemeskéri J, Harsányi L, Acsási G. Methoden zur Diagnose des Lebensalters von Skelettfunden. Anthropologischer Anzeiger 1960; 24: 70–95.

65. Schultz M. Paläopathologische Diagnostik. In: Knussmann R, editor. Anthropologie. Handbuch der vergleichenden Biologie des Menschen 1: Wesen und Methoden der Anthropologie. Stuttgart, New York: G. Fischer; 1988. pp. 480–496.

66. Scott GR, Winn JR. Dental chipping: contrasting patterns of Microtrauma in Inuit and European Populations. Int J Osteoarchaeol 2011; 21(6): 723–731.

67. Hillson S. Dental anthropology. Cambridge: Cambridge University Press; 1996.

68. Ubelaker DH. Human skeletal remains: excavation, analysis, interpretation. Chicago: Aldine; 1978.

69. Shewan L. Natufian settlement systems and adaptive strategies: the issue of sedentism and the potential of strontium isotope analysis. In: Delage C, editor. The last hunter-gatherer societies in the Near East. BAR, International Series 1320. Oxford: Hadrian Books; 2004. pp. 55–94.

70. Alt KW, Benz M, Müller W, Berner ME, Schultz M, Schmidt-Schultze TH, et al. Earliest evidence for social endogamy in the 9,000-year-old-population of Basta, Jordan. PLoS ONE 2013; 8(6): e65649. https://doi.org/10.1371/journal.pone.0065649 PMID: 23776517

71. Kinzel M. Am Beginn des Hausbaus. Studien zur PPNB Architektur von Shkarat Msaied und Ba’ja in der Petra-Region, SüdJordanien. Studies in Early Near Eastern Production, Subsistence, and Environment 17. Berlin: ex oriente; 2013.

72. All items of the grave are stored in the Petra Park Museum Deposits. Only five of the six turquoise beads were available in 2018 for microscopic analyses.

73. Alarashi H. The Epipaleolithic and Neolithic personal adornments from Syria (12th-7th millennium BC): techniques and uses, exchanges and identities [dissertation]. Lyon: University Lyon; 2014.

74. Alarashi H, Ortiz A, Molist M. Seashells on the riverside: Cowrie ornaments from the PPNB site of Tell Halula (Euphrates, Northern Syria). Quaternary International 2018; 490: 98–112.

75. Rosenberg D. Early maceheads in the southern Levant: a “Chalcolithic” hallmark in Neolithic context. J Field Archaeol 2010; 35(2): 204–216.
76. Makarewicz C, Rose K. Early Pre-Pottery Neolithic settlement at el-Hemneh: a survey of the architecture. Neo-Lithics 2011; 11(1): 19–25.

77. Benz M, Erdal YS, Şahin FS, Özkyavı A, Alt KW. The equality of inequality. Social differentiation among the hunter-fisher-gatherer community of Körtik Tepe, Southeastern Turkey. In: Mellart H, Hahn HP, Jung R, Risch R, editors. Rich and poor—competing for resources in prehistory. Tagungen des Landesmuseums für Vorgeschichte Halle 13. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen Anhalt, Landesmuseum für Vorgeschichte Halle (Saale); 2016. pp. 147–164.

78. Byrd B. Early village life at Beidha, Jordan: Neolithic spatial organization and vernacular architecture. British Academy Monographs in Archaeology 14. Oxford: Oxford University Press; 2005.

79. Nissen HJ, Muheisen M, Gelbel HG with contributions by Becker C, Hermansen BD, Karasneh W, Qadi N, Schultz M, Scherer A. Report on the excavation at Basta 1988. Ann Dep Antiqu Jordan 1991; 35: 13–40.

80. Goring-Morris AN. Life, death and the emergence of differential status in the Near Eastern Neolithic: evidence from Qfar HaHoresh, Lower Galilee, Israel. In: Clarke J, editor. Archaeological perspectives on the transmission and transformation of culture in the Eastern Mediterranean. Levant Supplementary Series 2. Oxford: Oxbow Books; 2005. pp. 89–105.

81. Purschwitz C. Die lithische Ökonomie von Feuerstein im Frühneolithikum der Größeren Petra Region. Studies in Early Near Eastern Production, Subsistence, and Environment 19. Berlin: ex oriente; 2017.

82. Rollefson GO, Kafafi Z. The 1995 season at ‘Ayn Ghazal. Preliminary report. Ann Dep Antiqu Jordan 1996; 40: 11–29.

83. Edwards S. An early Bronze Age basalt bowl and macehead from Khirbat al-Mudayna ath-Thamad. In: Neeley MP, Geoffrey AC, Michèle Daviau PM, editors. Walking through Jordan: essays in honour of Burton MacDonald. Sheffield: Equinox; 2017. pp. 13–24.

84. Wright K, Garrad A. Social identities and the expansion of stone bead-making in Neolithic western Asia: new evidence from Jordan. Antiquity 2003; 77(296): 267–284.

85. Hauptmann A. ‘Greenstones’ from Basta. Their mineralogical composition and possible provenance. In: Nissen HJ, Muheisen M, Gelbel HG, editors. Basta I. The human ecology. Bibliotheca Neolithica Asiae Meridionalis et Occidentalis and Yarmouk University, Monograph of the Faculty of Archaeology and Anthropology 4. Berlin: ex oriente; 2004. pp. 169–176.

86. Bar-Yosef Mayer DE, Porat N. Green stone beads at the dawn of agriculture. Proc Natl Acad Sci 2008; 24(105): 8548–8551.

87. Al Nahar M. ‘Ar’in Ghazal and Wadi Shueib: Neolithic personal ornaments. In: Finlayson B, Makarewicz C, editors. Settlement, survey, and stone. Essays on Near Eastern prehistory in honour of Gary Rollefson. Berlin: ex oriente; 2014. pp. 243–256.

88. Weisgerber G. Zur Entdeckung der Farben Rot, Grün und Blau. In: Lechevallier M, Ronen A, editors, Historia archaeologica. Festschrift für Heiko Steuer zum 70. Geburtstag. Berlin, New York: Walter de Gruyter; 2009; pp. 3–40.

89. Bangsborg Thuesen M, Kinzel M. Stone beads from Shkārat Msaid. Neo-Lithics 2018; 3–7.

90. Bar-Yosef Mayer DE. Changes in the selection of marine shells from the Natufian to the Neolithic. In: Bar-Yosef O, Valla FR, editors. The Natufian culture in the Levant. Archaeological Series 1. Ann Arbor: International Monographs in Prehistory; 1991. pp. 629–636.

91. Lechevallier M. Les éléments de parure et petits objets en pierre. In: Lechevallier M, Ronen A, editors, Le site de Hatoula en Judée occidentale, Israël. Mémoires et Travaux du Centre de Recherche Français de Jérusalem 8. Paris: Association Paléorient; 1994. pp. 227–232.

92. Maréchal C. Éléments de parure de la fin du Natoufien: Mallaha Niveau I, Jayroud 1, Jayroud 3, Jayroud 9, Abu Hureyra et Mureybet IA. In: Bar-Yosef O, Valla FR, editors. The Natufian culture in the Levant. Archaeological Series 1. Ann Arbor: International Monographs in Prehistory; 1991. pp. 589–612.

93. Spatz AJ, Bar-Yosef Mayer DE, Nowell A, Henry DO. Ornaments of shell and stone: social and economic insights. In: Henry DO, Beaver JE. The sands of time. The desert Neolithic settlement at Ayn Abū Nukhayla. Bibliotheca neolithica Asiae meridionalis et occidentalis. Berlin: ex oriente; 2014. pp. 245–258.

94. Purschwitz C. The prehistory of Tayma. The chipped stone evidence. The surface finds and a typological analysis of the chert artefacts from the camelian bead workshop SE 2. Zeitschrift für Orient-Archäologie 2017; 10: 288–311.

95. Fabiano M, Bema F, Borzetti von Löwenstein E. Pre-Pottery Neolithic amazonite workshop in southern Jordan. Actes du XIVème Congrès UISPP, Université de Liége, Belgique. Oxford: Aerchaeopress; 2014. pp. 265–273.
96. Schultz M, Berner M, Schmidt-Schultz TH. Preliminary results on morbidity and mortality in the Late PPNB population from Basta, Jordan. In: Bienert H-D, Gebel HGK, Neef R, editors. Central settlements in Near Eastern Jordan. Studies in Early Near Eastern Production, Subsistence, and Environment 5. Berlin: ex oriente; 2004. pp. 259–269.

97. Schultz M, Schmidt-Schultz T, Gresky J, Kreutz K, Berner M. Morbidity and mortality in the late PPNB populations from Basta and Ba'ja (Jordan). In: Faerman M, Horwitz LK, Kahana T, editors. Faces from the past: diachronic patterns in the biology of human populations from the Eastern Mediterranean. Oxford Archaeological Reports International Series 1603. Oxford: Archaeopress; 2007. pp. 82–99.

98. Molleson T. The eloquent bones of Abu Hureyra. Scientific American 1994; 271(2): 70–75. PMID: 8066433

99. Smith P. The dental evidence for nutritional status in the Natufians. In: Bar-Yosef O, Valla FR, editors. The Natufian culture in the Levant. Archaeological Series 1. Ann Arbor: International Monographs in Prehistory; 1991. pp. 425–432.

100. Bar-Yosef O. Warfare in the Levantine early Neolithic. A hypothesis to be considered. Neo-Lithics special issue 2010; 10(1): 6–10.

101. Simmons A, Rollefson G, Kafafi Z, Mandel R, Al-Nahar M, Cooper J, et al. Wadi Shu'eib, a large Neolithic community in Central Jordan: final report of test investigations. B Am Sch Oriental Re 2001; 321: 1–39.

102. Benz M, Alt KW, Erdal YS, Şahin FS, Özkaya V. Re-presenting the past. Evidence from daily practices and rituals at Körtik Tepe. In: Hodder I, editor. Religion, history and place in the origin of settled life. Boulder: University Press of Colorado; 2017. pp. 137–161.

103. Gresky J, Haelm J, Clare L. Modified human crania from Göbekli Tepe provide evidence for a new form of Neolithic skull cult. Science Advances 2017; 3(6): e1700564; https://doi.org/10.1126/sciadv.1700564 PMID: 28782013

104. Stordeur D, Khawam R. Les crânes surmodélés de Tell Aswad (PPNB, Syrie). Premier regard sur l’ensemble, premières réflexions. Syria 2007; 84: 5–32.

105. Benz M. “Little poor babies”—creation of history through death at the transition from foraging to farming. In: Kienlin TL, Zimmermann A, editors. Beyond elites. Alternatives to hierarchical systems in modelling social formations. Universitätsschriften zur Prähistorischen Archäologie 21. Bonn: Habelt; 2012. pp. 169–182.

106. Khawam R. L’homme et la mort au Néolithique précéramique B: l’exemple de Tell Aswad [dissertation]. Lyon: University of Lyon; 2014.

107. Ergül K. Contexte architectural des crânes surmodélés: diversité contextuelle et funéraire. Neo-Lithics 2015; 15(1): 11–23.

108. Starck JM. Comparative analysis of stone ring artifacts from Ba’ja and Basta. In: Garrard A, Gebel HG, editors. The prehistory of Jordan. The state of research in 1986. British Archaeological Reports International Series 396, Oxford: British Archaeological Reports; 1986. pp. 137–174.

109. Spatz AJ. Ornamental shell beads as markers of exchange in the Pre-Pottery Neolithic B of the southern Levant. In: Bar-Yosef Mayer DE, Bonsall C, Choyke AM, editors. Not just for show. The archaeology of beads, beadwork and personal ornaments. Oxford: Oxbow; 2017. pp. 69–80.

110. Kirkbride DD. Beidha: early Neolithic village life south of the Dead Sea. Antiquity 1968; 62: 263–274.

111. Reese DS. Marine shells in the Levant: Upper Paleolithic, Epipaleolithic, and Neolithic. In: Bar-Yosef O, Valla FR, editors. The Natufian culture in the Levant. Archaeological Series 1. Ann Arbor: International Monographs in Prehistory; 1991. pp. 613–628.

112. Hermansen BD. Raw materials of the small finds industries. In: Nissen HJ, Muheisen M, Gebel HGK, editors. Basta I. The human ecology. Bibliotheca Neolithica Asiae Meridionalis et Occidentalis and Yarmouk University, Monograph of the Faculty of Archaeology 4. Berlin: ex oriente; 2004. pp. 117–128.

113. Gebel HGK, Hermansen BD. Ba’ja Neolithic Project 1999: short report on architectural findings. Neo-Lithics 1999; 99(3): 18–21.

114. Gebel HGK, Kinzel M. Ba’ja 2007: crawl spaces, rich room dumps, and high energy events. Results of the 7th season of excavation. Neo-Lithics 2007; 07(1): 24–33.

115. Gebel HGK, Nissen HJ, Zaydoon Z, editors. Basta II. The architecture and stratigraphy. Bibliotheca Neolithica Asiae Meridionalis et Occidentalis and Yarmouk University, Monograph of the Faculty of Archaeology and Anthropology 5. Berlin: ex oriente; 2006.

116. Benz M. Beyond death—the construction of social identities at the transition from foraging to farming. In: Benz M, editor. The principle of sharing. Segregation and construction of social identities at the transition from foraging to farming. Studies in Early Near Eastern Production, Subsistence, and Environment 14. Berlin: ex oriente; 2010. pp. 249–276.
117. Benz M. Changing medialities. Symbols of Neolithic corporate identities. In: Benz M, Gebel HGK, Watkins T, editors. Neolithic corporate identities. Studies in Early Near Eastern Production, Subsistence, and Environment 20. Berlin: ex oriente; 2017. pp. 135–156.

118. Gebel HGK. Walls: loci of forces. In: Gebel HGK, Hermansen BD, Hoffmann Jensen C, editors. Magic practices and ritual in the Near Eastern Neolithic. Studies in Early Near Eastern Production, Subsistence, and Environment 8. Berlin: ex oriente; 2002. pp. 119–132.

119. Gebel HG, Muheisen M, Nissen HJ, Qadi N. with contributions by Becker C, Hermansen BD, Neef R, Shafiq RM, Schultz M. Late PPNB Basta: results of 1992. In: Bienert H-D, Gebel HGK, Neef R, editor. Central settlements in Neolithic Jordan. Studies in Early Near Eastern Production, Subsistence and Environment 5. Berlin: ex oriente; 2004. pp. 71–104.

120. Alt KW, Benz M, Vach W, Simmons TL, Goring-Morris AN. Insights into the social structure of the PPNB Site of Kfar HaHoresh, Israel, based on dental remains. PLoS ONE 2015; 10(9): e0134528. https://doi.org/10.1371/journal.pone.0134528 PMID: 26376321

121. Assmann J. Das kulturelle Gedächtnis. Schrift, Erinnerung und politische Identität in frühen Hochkulturen. 4th ed. München: C.H. Beck; 2002.

122. Bender F. Geological map of Jordan, Sheet Aqaba-Ma’an. 1:250,000. Hannover: Bundesanstalt für Bodenforschung; 1968.

123. Barjous MO. Geological map sheet, Ash Shawbak (3151 III), 1: 50,000. Amman: Hashemite Kingdom of Jordan, Ministry of Energy and Mineral Resources, National Resource Authority, Geology Directorate; 1988.

124. Barjous MO. Geological map Petra & Wadi al-Lahyana (3050 I & 3050 IV), 1: 50,000. Amman: Hashemite Kingdom of Jordan, Ministry of Energy and Mineral Resources, National Resource Authority, Geology Directorate, Amman; 1988.

125. Ibrahim KM, Rashdan M. Geological map Wadi Gharandal (3050 III), 1: 50,000. Amman: Hashemite Kingdom of Jordan, Ministry of Energy and Mineral Resources, National Resource Authority, Geology Directorate; 1988.

126. Kherfan AM. Geological map of Bir Khidad, (3150 IV), 1: 50,000. Amman: Hashemite Kingdom of Jordan, Ministry of Energy and Mineral Resources, National Resource Authority, Geology Directorate; 1998.

127. Rabb’a I. Geological map of Al-Quarayqira, Jabal Hamra Faddan (3050 III), 1: 50,000. Amman: Hashemite Kingdom of Jordan, Ministry of Energy and Mineral Resources, National Resource Authority, Geology Directorate; 1991.

128. Tarawneh K. Geological map of Ma’an (3150 III), 1:50,000. Amman: Hashemite Kingdom of Jordan, Ministry of Energy and Mineral Resources, National Resource Authority, Geology Directorate; 2002.

129. Balasse M, Al Zaidaneen JS, Dean RM, Price TD, Henry DO. Tracing herding patterns at Ayn Abū Nukhayla through biogeochemical analyses (\(^{15}C, {^{18}}O, {^{87}}Sr\)/{^{86}}Sr) in faunal remains. In: Henry DO, Beaver JE, editors. The sands of time. The desert Neolithic settlement at Ayn Abū Nukhayla. Bibliotheca Neolithica Asiae Meridionalis et Occidentalis. Berlin: ex oriente; 2014. pp. 91–104.

130. Edwards PC, editor. Wadi Hammeh 27, an early Natufian settlement at Pella in Jordan. Leiden: Brill; 2013.