Chapter 6
Reading Spoor

Epistemic Aspects of Indigenous Knowledge and its Implications for the Archaeology of Prehistoric Human Tracks

Tilman Lenssen-Erz and Andreas Pastoors

Abstract The spoor of animals and humans alike contain rich information about an individual and about a momentary activity this individual performed. If the – arguably hard-wired – human ability to read spoor and tracks is sufficiently trained, a footprint allows to glean from it various physical, kinetic, medical, social and psychologic data about an individual, as has been observed among various populations across the globe. The Ju|'hoansi San from northern Namibia still today practice traditional hunting so that tracking is a skill that is required and trained on a daily base. For a good tracker, the information she or he gets from spoor is equally rich on animal and human footprints, and it is not necessary that the tracker has been exposed before to the individual whose spoor she/he reads. In order to allow an assessment of how tenable are the interpretations by contemporary hunter-gatherers of prehistoric human footprints, this chapter elucidates methodological aspects of tracking and situates this ability in an epistemological framework.

Keywords Hunter-gatherers · Tracking · Induction · Deduction · Abduction · Hypothetico-deductive reasoning · Tacit knowledge

T. Lenssen-Erz (✉)
African Archaeology, University of Cologne, Cologne, Germany
e-mail: lenssen.erz@uni-koeln.de

A. Pastoors
Institut für Ur- und Frühgeschichte Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany
e-mail: andreas.pastoors@fau.de

A. Pastoors, T. Lenssen-Erz (eds.), *Reading Prehistoric Human Tracks*,
https://doi.org/10.1007/978-3-030-60406-6_6

Introduction

Human footprints are most prominent among the long-time under-researched features of the context of cave art. In order to compensate for this neglect, a special research programme has focused on the merging of indigenous knowledge and Western archaeological science for the benefit of both sides. With the expert assistance of indigenous San hunters from the Namibian Kalahari, the Tracking in Caves project endeavoured to better understand aspects of the Upper Palaeolithic human behaviour, traces of which are preserved in footprints in painted caves in southern France. The three professional indigenous trackers, Thui Thao, /Ui Kxunta and Tsamgao Ciqae (e.g. Pastoors et al. 2015. Lenssen-Erz et al. 2018), were invited to Europe and conducted in-depth research in the caves Niaux, Pech Merle, Fontanet, Tuc d'Audoubert and Aldène (Fig. 6.1 – see Pastoors et al. Chap. 13).

The extent of preservation of footprints from the Pleistocene depends on advantageous taphonomic circumstances and on careful treatment of the caves after modern rediscovery. Accordingly Pech Merle has less than 20 footprints, but the other caves each have at least several dozens and some several hundred. In Aldène they were left behind by visitors during the Mesolithic, Niaux is insufficiently dated, all others are of Upper Palaeolithic origin.

The documentation of the interpretations of the indigenous ichnologists is indispensable if they should be analysed archaeologically, but it is no less important to cross-check the results obtained with the results of the studies of Western sciences. The circumstance that the results of indigenous ichnologists are difficult to evaluate does not imply that they are worthless assumptions. They have to be verified or falsified with quantitative analyses and integrated into the discussion of prehistoric human footprints.

Even though the art of tracking has already been described comprehensively (Liebenberg 1990), there is a certain neglect of it in the current discourse of archaeology on prehistoric human tracks. In order to allow due appreciation of the

Fig. 6.1 The San ichnologists Thui Thao, Tsamgao Ciqae and /Ui Kxunta during their spoor investigations in the cave of Tuc d'Audoubert

methodological foundations of indigenous ichnologies, this chapter focuses on the art of tracking and its implications for the archaeology of prehistoric human tracks.

The Art of Tracking

With his ground-breaking book The Art of Tracking, the Origin of Science, Louis Liebenberg (1990) opened up new perspectives on the profoundness and epistemological complexity of the indigenous knowledge of tracking. Having immersed into the tracking culture of southern African San hunters, he understood that tracking is an intricate edifice of thought that stands a comparison to established sciences in Western cultures:

> In the narrowest sense of the word 'spoor' simply means 'footprint', but in tracking it has a much wider meaning, including all signs found on the ground or indicated by disturbed vegetation. Tracking also involves signs such as scent, urine and faeces, saliva, pellets, feeding signs, vocal and other auditory signs, visual signs, incidental signs, circumstantial signs, blood spoor, skeletal signs, paths, homes and shelters. Spoors are not confined to living creatures. Leaves and twigs rolling in the wind, long grass sweeping the ground or dislodged stones rolling down a steep slope leave their distinctive spoor. Markings left by implements, weapons or objects may indicate the activities of the persons who used them, and vehicles also leave tracks. [. . .]
>
> Spoor includes a wide range of signs, from obvious footprints, which provide detailed information on the identity and activities of an animal, to very subtle signs which may indicate no more than that some disturbance has occurred. [. . .] Signs of spoor may vary considerably with terrain, weather conditions, season, time of day and age. (Liebenberg 1990: 111–113)

Summing up the fields of knowledge that need to be mastered for successful tracking shows that reading spoor goes far beyond pattern recognition (cf. Gagnol 2013: 175). Tracking requires detailed zoological knowledge (behaviour, seasonal changes, reproduction, feeding habits, etc.) of the prey but also of animals in context including small mammals, reptiles, insects, etc. They may provide additional information if, e.g. a nocturnal animal walks through the spoor of a tracked animal, thus indicating how old a seemingly fresh track may be. Also all topics of ecological knowledge are part of the tracking skills with deep insights into biosphere and geosphere as well as pedology regarding the influence of different soil qualities on the ageing of spoor. The same applies for meteorological knowledge and weather observations that have to be memorized, e.g. in knowing which were the prevailing wind directions in the past 24 h. On top of this, each tracker needs to have exact knowledge of the place/area regarding vegetation, water points, game trails, salt licks, etc., all of which may be points of orientation for movements of animals. But also in his or her own interest, a tracker needs to have an absolute sense orientation (e.g. Brenzinger 2008), first to find the way home and second to being able to communicate spots in the landscape to others (e.g. the place where the carcass of a hunted animal is lying).

Also the potential of tracking to identify individuals is explained by Liebenberg:

> While species can be identified by characteristic features, there also exist individual variations within a species. These variations make it possible for an experienced tracker to determine the sex as well as an approximate estimation of the animal's age, size and mass. A tracker may also be able to identify a specific individual animal by its spoor. [. . .]
>
> The age of an animal may be indicated by the size of the feet. The hoofs of young antelope will also have sharper edges, while old individuals may have blunted hoofs with chipped edges. With animals with padded feet, younger individuals may have more rounded pads. Some animals have specific breeding periods. If it is known at what time of year an animal is born, a reasonably accurate estimate of its age can be made. [. . .]
>
> Apart from features characteristic to the species, there also exist random variations within the species which may vary from individual to individual.
>
> The exact shape of every individual is unique so that it is, in principle, possible to identify an individual animal. In practise this requires considerable experience, and is usually only possible with large animals. With elephant and rhinoceros it is easy to identify an individual by the random pattern of cracks underneath the feet.
>
> The shape of feet may also be altered by environmental factors. In hard terrain, hoofs of ungulates may be blunted by excessive wear, or in soft, sandy terrain, they may grow elongated hoofs due to lack of natural wear. (Liebenberg 1990: 122–124)

All which is said here on animal tracks is analogically found in human spoor (e.g. Biesele and Barclay 2001; Lowe 2002; Gagnol 2013; see Gagnol Chap. 19) since once the subtle reading is trained, it makes no difference to which type of trace the skill is applied. Therefore trackers are able to interpret many other signs of animals, e.g. where and how they were lying on the ground or if there were two animals fighting and rolling over the ground skilled trackers will be able to reconstruct complex sequences of movements and interaction. It also means that trackers are able to follow the tracks of an individual – be that person, game or herd animal – under changing soil conditions and even if mixed with imprints of other individuals of the same species.

Apart from these fields of knowing that are implied in tracking, it was also Liebenberg who pointed out that reading spoor means methodologically building hypotheses based on empirical evidence and that these hypotheses are constantly tested against ever new data (observations, perception; Liebenberg 1990: 153–157).

Methodological Aspects of Tracking

As Liebenberg has described in detail tracking, i.e. reading tracks is a special skill that is a precondition for human hunting and therefore may be considered the beginning of science (Liebenberg 1990). As such, it is related to ichnology, the science of tracks and traces, which originally was mainly occupied with fossil tracks (such as of dinosaurs), but since the discovery of the earliest hominid footprints in Laetoli (Tanzania) has also turned to humans (Lockley 1999). In current research of prehistoric human footprints, Western science reveals essentially two approaches: first, footprint outline and landmark-based geometric-morphometric analyses (e.g. Bennett et al. 2009, 2016) and, second, pixel-based quantitative analysis of the whole foot pressure (e.g. Crompton et al. 2011).

In pre-industrial societies of hunter-gatherers and herders, mastery of track reading is an existential necessity. It is being learned from early childhood onwards, requiring lifelong learning and constant practice. The reference to personal experiences and personal exposure to the object of description is at the same time a reference to the fact that tacit knowledge (Polanyi 1966) is required in tracking to a considerable extent comprising knowledge and cognitive possibilities that cannot be made explicit but rather are specifically available to each individual through an embodiment of experience.

Presently indigenous ichnology has a much finer resolution of tracks than modern morphometric methods since trackers are normally able to determine from a footprint the sex and the approximate age class of a person, where the latter is not a factor of body height but based on overall foot proportions and traces of ageing.

Indigenous ichnology is not based in rationality, logic or causalities that differ drastically from Western views, as may be the case with traditional ecological knowledge (TEK) (Berkes 2008: 8). Nevertheless, taking a series of scientific measurements (e.g. Pales 1976; Webb 2007; Kinahan 2013; Ashton et al. 2014) is an unsatisfactory substitute and cannot produce understanding, as opposed to reading the ground for tracks (Chamberlin 2002). Expert tracking produces a narrative that is based on in-depth knowledge of the entire ecosystem and its agents, acquired through experience (Liebenberg 1990; Blurton Jones and Konner 1976; Lowe 2002). The capabilities of hunter-gatherers in reading tracks are legendary throughout various types of literature (e.g. Marshall Thomas 1988; Liebenberg 1990; Biesele and Barclay 2001; Lowe 2002), and no knowledgeable author leaves a doubt regarding the reliability of the trackers' skills. And also among traditional herders, equally deep analysis of tracks is found (Gagnol 2013). But despite the presence of prehistoric tracks on all continents (Lockley et al. 2008; Pasda 2013), only very little, rather anecdotal use has been made of indigenous tracking knowledge in archaeological contexts (Webb et al. 2006; Franklin and Habgood 2009).

As regards scientific scepticism about the reliability of spoor analyses by indigenous ichnologists, there have been empirical tests under controlled conditions with very high rates of accurateness of 98% (Stander et al. 1997) or 74% inter-rater reliability (Wong et al. 2011). The first study tested a group of San trackers of which Thao was part and the task was to determine for animal spoor the species, sex and age class of the animal and how old the spoor was. The second study aimed at determining whether spoor reading by Inuit hunters would be reliable enough for collecting census data on polar bears – which indeed was confirmed by the study. Furthermore, the two main ichnologists of the present study (Kxunta and Thao) have both passed the CyberTracker tracking certification (http://www.cybertracker.org/downloads/tracking/CyberTracker-Tracker-Certification-2018.pdf) with accuracy results of >90% (pers. comm. Liebenberg 2018).

If the method of tracking is analysed epistemologically, it is linked to Western scientific thought by the intellectual procedures of inductive, deductive and abductive reasoning (after C. S. Pierce 1955, cf. Liebenberg 1990; Eco and Seboek 1988) as three options to build hypotheses in the interpretation of observations (Fig. 6.2). Abduction, for that matter, can be described as a process that:

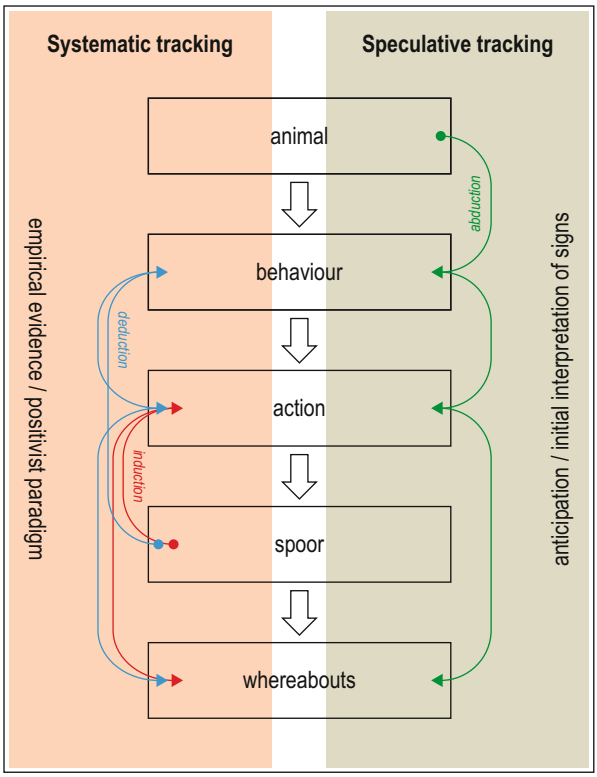

Fig. 6.2 Representation of the tracking process after Liebenberg (1990) with three types of reasoning and two principal paradigms of finding out the whereabouts of an animal or person

> begins with observations and then proceeds in a back-and-forth process of developing hypotheses and comparing the observations with information known and filed in memory. [...] Abductive reasoning then assembles the observations and attributes a variety of characteristics or conditions to a subject until a match is made and an hypothesis or conclusion can be stated. (Moriarty 1996: 181)

In following a spoor, the three methods of deriving conclusions, according to Liebenberg, are realized in an inductive-deductive practice which he labels systematic tracking, and a hypothetico-deductive (or abductive) one, termed speculative tracking (Fig. 6.2; Liebenberg 1990: 106–108). The former method rests quite narrowly with the observations the trackers make on the spoor they follow, thus forcing them to walk the same way as the pursued animal walked. The latter method makes an educated guess about what a pursued animal is going to do next on the basis of information gathered from the spoor up to a given moment and on general knowledge of the animal's behaviour. Thus the trackers may leave the spoor and take a shortcut to the place where the spoor is expected to be retrieved again. Gagnol, building on his own tracking research among Saharo-Sahelian camel herders, also found that successful tracking is importantly based on abductive method and what Liebenberg calls speculative tracking resounds in what Gagnol terms stratégie hodologique (Gagnol 2013: 172; Gagnol et al. 2018: 21; hodology = study of

pathways; see Gagnol Chap. 19). The essence of both methods lies in the principle of liberating the search process of tracking from the dependence of visible spoor but instead making educated assumptions about what the subject may have chosen to do. In Gagnol's words:

> One imagines the general path, the assumed goal of the animal or person and the means or stratagems he or she will apply to achieve it (therefore one has to adopt his or her point of view, putting oneself in the perspective of the other). (Gagnol 2013: 173; translation from French TLE[1])

In view of such intellectual processes, deriving conclusions from observations Liebenberg emphasizes their complexity which is no less than that of modern scientists, e.g. in physics or mathematics (Liebenberg 1990: 45–46). Accordingly, upon thorough study of the character of tracking, authors have no doubt of the status of tracking as analogous to science or as its forerunner (Liebenberg 1990; Jones and Konner 1976; Chamberlin 2002). Ciqae, Kxunta and Thao assert that the decisions of trackers who hunt together and their interpretation of spoor are both based on constant exchange of opinion as well as on shared expert statements amongst the trackers (see also Liebenberg 1990; Blurton Jones and Konner 1976; Biesele and Barclay 2001). Therefore tracking can be accepted as a serious methodology in an epistemological sense, and trackers are justifiably labelled ichnologists since their professional practice largely is the interpretation of positivist data through reason and logic, based upon clearly determinable, repeatable methods. Further corroboration for this epistemological assessment of tracking is provided in the fact that for the differentiation of, e.g. male and female footprints, trackers assess the same markers and proportions on a foot as in orthopaedics or forensics (e.g. Robbins 1985; Reel et al. 2010) (Fig. 6.3).

At this juncture it must not go unmentioned that in hunter-gatherer societies, skills in tracking are not the exclusive knowledge of adult male hunters, and as mentioned before these skills are not restricted to animal tracks but also include human spoor (cf. Marshall Thomas 1988: 26; Biesele and Barclay 2001: 79; Lowe 2002: 18, 68; see Gagnol Chap. 19 and Gagnol 2013 for tracking skills of herders).

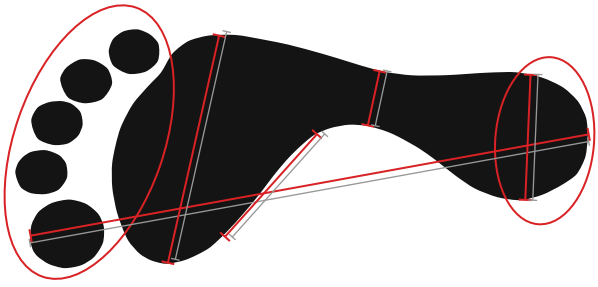

Fig. 6.3 Ways of taking data from a footprint: *grey* lines are usually measured in orthopaedics and forensics; the *red* line represent the measures San ichnologists assess. The *circles* circumscribe areas that are assessed in their totality, in particular for age estimations

[1]In original text: "On imagine le parcours général, le but supposé de l'animal ou de la personne et les moyens ou stratagèmes qu'il ou elle mettra en œuvre pour y parvenir (il fout donc adopter son point de vue, se placer dans la perspective d'autrui)."

And as is the case with all human abilities, not every hunter or every herder in a given group is equally good in that skill (Liebenberg 1990; Gagnol 2013). There are always some trackers who through talent, persistence and ambition reach levels of mastery so that they can read spoor which would leave other members of their groups helpless.

Gagnol (2013; see Gagnol Chap. 19) in his research among Touareg (Niger) and Toubou (Chad) camel herders regarding their capability of reading spoor confirms all findings that have been reported by other authors on hunter-gatherers – even though he seems to be totally unaware of this literature. For these herders it is normal to have extraordinarily fine resolution of reading tracks regarding human spoor and regarding their domestic animals like camel, horse, cattle, donkeys, goats and sheep (Gagnol 2013: 171). Gagnol also points out that this expertise goes together with a rich vocabulary for the description of spoor details and of ways of walking (Gagnol 2013: 170). For a camel herder, it is important to know all his animals by their spoor, even if they may mix with another herd (which does not happen infrequently), and if they get astray, the herder will occasionally track it for several days (Gagnol 2013: 170).

As regards human spoor, Gagnol asserts that every individual of a community can be identified by her or his footprint, and also strangers are recognized due to their unknown imprints. Such identification is not only based on morphological features but also on details of the habitual gait of a person – and wearing sandals is not an impediment for such identification (Gagnol 2013: 171). In following thieves the best trackers are even able to track the culprit if he changes his shoes several times during his escape (one of the strategies of camel thieves to complicate pursuit; Gagnol 2013: 179; see Gagnol Chap. 19). Information imprinted through a human footprint is so rich that even social status or ethnic affiliation can be gleaned from spoor (Gagnol 2013: 176; see Gagnol Chap. 19).

The described capability of extracting information from footprints was the basis for analyses of human footprints in the Palaeolithic caves. The results of the indigenous ichnologists compiled in the course of the various studies are as detailed and precise as the tracking by masters would promise, and they go beyond the results produced by Western science. This fact is perceived and reacted to in different ways by the public. If exposed to the results, one part of the public shows scientific curiosity, wishing to learn more about the capabilities of indigenous ichnologists and to verify or falsify the results through their own investigations. Others, however, show great scepticism to the extent of rejection. Such rejection does not seem appropriate without empirical falsifications, because indigenous ichnologists have verified skills in reading tracks. Strictly speaking, their methodological approach is not so alien to Western scientific approaches. Even though Erwin Panofsky's iconographic interpretation method refers to images, there are parallels between reading tracks and interpreting images. According to Panofsky, in the case of a natural subject as the object of interpretation, a pre-iconographic description of the motifs takes first place (Panofsky 1962). Practical experience (familiarity with objects and phenomena) is an absolute prerequisite for a successful description, from which a positive correlation between experience and descriptive accuracy can

be derived. In the event that the spectrum of personal experience is not sufficient, this spectrum must be extended by consulting publications or experts. Practical experience, in turn, helps to determine which publication or professional is to be consulted (Panofsky 1962: 9). This practical experience results not least from personal experiences in the world in which we live and which:

> provides the ground for all cognition and for all scientific purpose. (Husserl 1939: 38)

The concept of the lifeworld that is evoked here describes the realm of reality in which every human being inevitably participates (Schütz and Luckmann 1975). This concept asserts that there is a world of common, everyday experiences and interpretations on which all more theoretical knowledge is dependent (Schütz and Luckmann 1975: 23). A basic characteristic of the everyday lifeworld is its intersubjectivity, by which it forms a social world in which practically all members of a social body take part with roughly the same interpretations of daily phenomena (Schütz and Luckmann 1975: 33). The everyday lifeworld, seen as the most common and widest accepted kind of reality, comprises physical objects, nature and the everyday social world (Schütz and Luckmann 1975: 41).

Accordingly we contend that many processes and phenomena in the empirical world out there are understandable irrespective of the cultural imprinting an observer has. Based on this lifeworld concept, we regard phenomena like spoor as providing information on an implicit and an explicit level, the understanding of which is informed by tacit and by explicit knowledge (after Polanyi, e.g. 1966). While the implicit information is entirely embedded in the respective culture, or, as tacit knowledge, even within an individual (and therefore largely inaccessible to us, Polanyi 1966, see also Schütz and Luckmann 1975: 99–102), the explicit information is based in intersubjective experiences in the empirical world. Reading animal tracks cannot be separated from the actual behaviour of that species which the animals perform irrespective of any cultural representation and symbolization of this behaviour. Observing animal behaviour and the tracks it produces is a general human experience and is based on positivist, empirical data while the sense that is interpreted into such experience is subjective and culture-bound (Schütz and Luckmann 1975: 101). As has been pointed out before, everything that can be said on animal spoor also pertains to human footprints.

Implications for the Archaeology of Prehistoric Human Tracks

In archaeology, already at the beginning of the twentieth century, certain perplexity and a lack of experience with regard to the reading of tracks in the interpretations of prehistoric footprints in caves by Western scientists became apparent (e.g. Bégouën 1928; Lemozi 1929). Thus, not the recognition of a specific sequence of footprints gave reason to interpretations as ritual dance (de Contenson 1949) but the transfer of the generally perceived ritual status of the surrounding cave to the footprints. At this

point of archaeological analysis, lacking the capability to read tracks was masked by the professional practice of interpreting cultural-historical processes. Even today not only the lack of practical experience in reading tracks proves to be problematic but also the existence of methodological limits of modern analytical procedures. This is particularly evident in the difficulty of making the sequence of steps of one and the same person morphometrically visible, even though it is obviously from one person (Bennett and Morse 2014).

Against the background of interpretations favouring ritual activities, the results of the indigenous ichnologists appear unspectacular. But they fill a vacuum of description with content. An accumulation of footprints on a spatially limited area seems like a chaotic mixture. This confusion dissolves when the indigenous ichnologists combine footprints into sequences of steps of single individuals. For this purpose it is indispensable that age, sex and individual characteristics of a person can be gleaned from the footprint even if this is not possible with all of the extant Pleistocene footprints. The demographic data is ultimately established by using morpho-classificatory factors, which are essentially based on the same features that Western science also uses.

Contextual information is also included in the track data acquisition: the nature of the ground, room height, inclination, gradient, curvature, possible obstacles and much more. The identified footprints are mapped and recorded in a data sheet. As mentioned above, the result of the work of the indigenous ichnologists is not an inventory of all footprints but of footprints about which they can give dependable information. In this way, the indigenous ichnologists' approach differs from that of Western science, in which each individual footprint is recorded by using specific attribute systems thus favouring description over interpretation. Ultimately, the discussions about these two approaches are comparable to the dichotomy in archaeology between two well established methods of object analysis: the static attribute analysis and the dynamic analysis of the chaîne opératoire. Each footprint is the result of a unique interplay of bones, muscles and various other external factors and represents therefore a non-repeatable event. But footprints, or human tracks in general, are not alone with this situation in archaeological research. Every archaeological object is the result of certain constellations of internal and external factors that cannot be reproduced accurately. Archaeological research has responded to this dilemma by developing dynamic methods of investigation, including the chaîne opératoire.

Another dynamic method is the indigenous knowledge of tracking; therefore its application is not a matter of romanticism, and it is not aimed at providing an exotic view of tracks from another world-view. Rather, it provides alternative interpretations of data, using the same empirical base that is accessible to any method (Liebenberg 1990; Lockley 1999; Lowe 2002). To the present knowledge, there is no other method for a deep understanding of spoor as remains of dynamic actions that is equally successfully applicable to tracks in all kinds of substrate and in all stages of taphonomic degradation. Western science responds to this situation by applying experimental archaeology in order to develop a dynamic method (e.g. see Ledoux et al. Chap. 4).

In fact, the interpretations of human footprints by Ciqae, Thao and Kxunta achieve levels of precision described by Liebenberg and Gagnol. This prompts questions as to which aspects of the footprint are significant for such detailed information. Liebenberg compiles different aspects of the spoors, which serve as a base for the determination of age and sex, size, depth, way of movement, body structure and association with other footprints, all of which is supported by Gagnol's observations. Ciqae, Thao and Kxunta corroborate that a male foot looks stronger and wider than a female foot, indicating that, of course, an intuitive assessment of proportions is the foundation of sex determination besides gait and step length. According to Liebenberg (1990), wear, foot tension and again size are significant for age determination, which paraphrases the criteria mentioned and judged by the trackers. Furthermore, Liebenberg noted that the exact shape of every individual is unique, and, therefore, it is possible to identify individual animals and also humans (the same is maintained for Australian aboriginal people by Lowe 2002 and for Saharan nomads by Gagnol 2013). This, too, is substantiated by Ciqae, Thao and Kxunta, who assert that, in particular, the shape of the toes and the way a foot is set on the ground help them to identify their family, neighbours and friends by their footprints. Also, age determination of a known or unknown person, so Ciqae, Thao and Kxunta affirm, is largely based on judgments of the features of heels and toes, plus a person's way of walking, since steps become shorter as a person grows old (see also Gagnol 2013 for corroboration). Through this fine-grained differentiation, they are able to distinguish different age classes among adults, even though mature feet do not continue to grow. According to these trackers, the heels become harder and more cracked the older a person gets, and also the toes become harder. Through this, so the indigenous ichnologists maintain, the soil is being thrown up by the toes in a different way by an old person than by a younger adult. Gagnol (2013: 171–172) describes analogous changes from young adults to mature adults among the animals of the Toubou and Tuareg.

In a critical appreciation of the implementation of indigenous ichnology in archaeology, it has to be conceded that there may be some influential factors that could generate possible biases. After all the original context of the spoor that the indigenous ichnologists were asked to read stems from a period, environmental conditions and population that were all entirely alien to the tracker's previous experiences. When addressing this problem with the ichnologists, they maintained that people are people and reading the tracks of complete strangers is not uncommon for them. Nevertheless, the following questions are some of those that may arise:

- Which data are collected?
- How do participants communicate?
- Can technical terms be translated?
- Do means of control apply (verification/falsification)?
- Are there repeatable results?
- Is there a second opinion?
- How indigenous is indigenous knowledge?

First, it has to be emphasized that there is a general counter balance to these biases by the practice of the San trackers which, again, shows that their approach to data (tracks in this case) has much in common with a Western view of scientific investigations (this list is based upon observations and interviews during common field work):

- Empirical approach
- Meticulous exactness
- Best-practice ethics
- Constant testing of hypotheses
- Shared expert opinion
- Prepared for constant learning
- Immediate transfer and implementation of new experiences

Secondly and more specifically, data acquisition always takes place with intense communication among the indigenous ichnologists and with the archaeologists. In particular the internal exchange between the indigenous ichnologists is a guarantee that all results that are stated are based on the inclusion of at least a second expert opinion. Repeated visits to some spoor fields in French caves showed in a random test that interpretations of imprints were the same after 3 years so that the results indeed are repeatable – even if conceding that the same persons interpreted the spoor on both occasions. It is also important to emphasize that the data that are collected for the Tracking in Caves project are the same as those which interest a tracker also outside the research scheme: what are the characteristics of that person who left a spoor and do I know her or him, where did she/he go, and what was her/his state of mind and maybe her/his intentions (cf. Gagnol et al. 2018: 20). Therefore the questions arising from the research are fully understandable to trackers, while they do not mind the ultimate consequences of their spoor identifications. Notwithstanding this initial focus on every footprint in isolation, the analyses in the caves never produced contradictory actions or behaviour. For example, in cases of footprint superimpositions, the younger spoor would always be the one leading out of the cave.

The indigenous ichnologists admit, however, that normally they would only be interested in fresh spoor because tracking is a behaviour that generates information for immediate action which is futile regarding old spoor.

With regard to due scientific doubt about the initial results of spoor reading, there is no independent, more reliable scientific method available, and every new interpretation by other trackers of once interpreted spoor would constitute just another opinion but not a verification or falsification.

Whether the analyses of the San trackers depend on specific terminology in Jul'hoansi language for which there may be no equivalent in English is still a desideratum of research, but first investigations in other San languages clearly point into this direction (e.g. Sands et al. 2017).

Finally the question of how indigenous the indigenous knowledge really is has no relevance for the research questions. The reading of Pleistocene human footprints aims at getting the maximum possible information from footprints, no matter in

which way the interpreting experts acquired their knowledge. But it is only in the context of a life in rural areas where free roaming animals have outstanding economic significance where tracking is required and trained to such an extent that the most skilled individuals attain world class knowledge.

The Wider Potential of Tracking

The extraordinary abilities of indigenous ichnologists can also be applied in other fields of archaeological research. Particularly the ancient rock art of prehistoric hunter-gatherers may become a promising study object since in many regions around the globe, there are traditions of prehistoric art where animal tracks are an integral part of the rock art motif spectrum (Lenssen-Erz et al. forthcoming for an overview; Fig. 6.4). Considering that these depictions were produced by artists with the mindset of hunter-gatherers, it is obvious that reading and interpreting them is best attempted by hunter-gatherers themselves. Two pioneering field studies in Namibia indeed showed that in hundreds of engravings of animal spoor, indigenous ichnologists were not only able to identify in almost all cases the exact animal species (Nankela 2017) but also to determine sex and age class of an animal as well as which of the four legs was depicted (Lenssen-Erz et al. forthcoming). The latter study established three main findings: first the prehistoric hunter artists did not think in generic categories by producing an exemplary track of, e.g. giraffe as is found in field guide books for spoor identification. Rather for each depiction a hunter artist would conceive of a specific animal, e.g. a young male, and of this animal it would be a particular leg that was represented by the engraved spoor.

Secondly the spectrum of species represented by spoor is much richer than the spectrum of animals being depicted as figures, with a fair number of rather small animals. Also the frequency of predators, especially various species of felines, is much higher. Apparently the spoors of animals cover a different field of symbolization than the depictions of animal silhouettes.

Fig. 6.4 San ichnologists Ciqae, Kxunta and Thao reading spoor in prehistoric engravings in central Namibia's Doro !nawas region

And thirdly it emerged that instead of producing a random distribution of all possible features across all species that form part of the art canon, each species shows a clear bias towards a sex, an age class and a particular leg that is preferably depicted. The patterns that emerge cannot yet be interpreted because they produce alliances that are not self-explicatory: for example, the features of being predominantly female is shared by leopard and guinea fowl, while zebra and duiker are predominantly male; walking direction of almost all animals is up the wall, but duiker and springbok predominantly walk down the wall. Whether such associations have a common cognitive or symbolic base cannot be determined yet.

However, there are several reasons why it is necessary for a tracker to being able to determine sex, age and which of the four legs of an animal are indicated by a spoor. In the first place, a hunter must be able to identify an individual animal within a herd in order to be sure which animal he is tracking and hunting. Secondly the hunter must be able to identify each leg of an animal separately, on the one hand to understand the individual gait of every animal and on the other hand to see on which leg it may be lame, e.g. through the impact of the arrow he launched. Thirdly, if coming upon the spoor of a herd or pack of animals, it is important to quickly get an overview of how many animals are in this herd or pack – not only for hunting but also for security reasons: it requires different levels of alertness and caution if one comes upon the fresh spoor of lion whether these were left behind by two lions walking up and down in a place or whether these spoor stem from a pack of nine lions (pers. comm. O. Vogels 2019).

There is another field of indigenous knowledge that is connected to tracking which may be applicable in archaeology, notably rock art research. Indigenous ichnologists are capable to reconstruct from tracks the behavioural body postures of animals, be that game or domesticated animals, and therefore they are also well trained ethologists. Various rock art traditions, be they created by hunter-gatherers or herders, depict animals of significance for that culture in rich variations of body postures and gregarious configurations. Since archaeologists lack the training of reading spoor as much as the training of reading behaviour, their interpretation of animal behaviour depicted in rock art can only be rather superficial (e.g. Thackeray 1983; Lenssen-Erz 1994; Hollmann 2005). Involving the ethological knowledge of hunter-gatherers or pastoralists respectively to the specific art traditions made by their forerunners will certainly open new fields of meaning to these art corpora.

Conclusion

While giving tracking as indigenous knowledge a centre-stage position, this chapter does not aim at providing a critical review of the concept of indigenous knowledge since there is a broad literature on this subject (for an overview Odora Hoppers 2002). Indigenous knowledge shares at least a semantic field if it is not identical with terms such as traditional knowledge, local knowledge, civic science, traditional ecological knowledge, community archaeology, etc. Flaws of the indigenous

knowledge concept are sometimes discussed due to its association with notions such as nativism, essentialism, ethnicity of knowledge, ahistorical knowledge, (romantic) notion of being static and bound, belief vs. analysis, tradition vs. modernity or knowledge as a result of power relations. While being aware of this discourse, we need not make a contribution to it. We do not imply that the indigenous knowledge we work with necessarily has to be a pristine knowledge, but instead we involve San ichnology because it is the highest standard we can get today and it promises to get the maximum possible information that can be retrieved from an imprint for which there are not yet any equally yielding machine-based analytical devices.

Further research is necessary to determine the smallest analytical steps of the methodology applied by Ciqae, Thao and Kxunta to each single imprint. We do have some indications about the procedure of extracting data from a footprint, manifested in the sections of a foot that are part of the rating process and which are also used in orthopaedics or forensics (Fig. 6.3). But this can only be the start and in order to collect first data on this topic, the entire determination process in each cave was recorded as audio protocols. The transcription and translation of the discourses of the trackers will serve as an important resource in the future for the deeper understanding of indigenous ichnology.

In the course of the two field studies 2013 and 2018, especially the last, there were no inconsistencies or contradictions in the interpretation of the approximately 1000 prehistoric human footprints examined. This expresses the professionalism and quality of the work of the indigenous ichnologists.

Currently preparations are under way to analyse most of the footprints examined by indigenous ichnologists, using quantitative methods in order to verify or falsify their results in the form of a cross-test with new methods. It will be a central task to combine Western science with indigenous ichnology and to discuss the results of both approaches. A main problem is certainly the difficulty of evaluating the results obtained by the indigenous ichnologists. But their integration into the interpretation of prehistoric footprints is still in its infancy. Following the principle of Aristotle, where the whole is more than the sum of its parts, indigenous ichnologists include the behaviour of the trackmaker in their interpretations from the beginning. For Western scientists, footprints are individual morphological features that are quantified as such, disconnected from the other footprints. The question of the behaviour of the trackmaker is handled separately and comes at the end of the statistical analyses. This methodical contrast offers great potential and promises benefits for both sides.

For the future, these experiences mean that by applying indigenous knowledge, selected source genres of archaeology can be explored in greater depth than would be the case with conventional methods alone. While the case described here was about the knowledge of hunter-gatherers, it is to be expected that the addition of, for example, pastoral nomads in other fields of research and for other epochs will also lead to new and deeper insights.

References

Ashton, N., Lewis, S. G., Groote, I. D., Duffy, S. M., Bates, M., Bates, R., Hoare, P., Lewis, M., Parfitt, S. A., Peglar, S., Williams, C., & Stringer, C. B. (2014). Hominin footprints from early Pleistocene deposits at Happisburgh, UK. *PLoS One, 9*(2). https://doi.org/10.1371/journal.pone.0088329.

Bégouën, H. (1928). *Les empreintes de pieds préhistoriques* (pp. 323–328). Amsterdam: Congrès International d'Anthropologie et d'Archéologie Préhistorique III.

Bennett, M. R., Harris, J. W. K., Richmond, B. G., Braun, D. R., Mbua, E., Kiura, P., et al. (2009). Early hominin foot morphology based on 1.5 million year old footprints from Ileret, Kenya. *Science, 323*, 1197–1201.

Bennett, M. R., & Morse, S. A. (2014). *Human footprints: Fossilised locomotion?* Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-08572-2.

Bennett, M. R., Reynolds, S. C., Morse, S. A., & Budka, M. (2016). Laetoli's lost tracks. 3D generated mean shape and missing footprints. *Scientific Reports, 6*, 21916. https://doi.org/10.1038/srep21916.

Berkes, F. (2008). *Sacred ecology: Traditional ecological knowledge and resource management*. New York: Routledge.

Biesele, M., & Barclay, S. (2001). Jul'hoan women's tracking knowledge and its contribution to their husbands' hunting success. *African Study Monographs*, (Suppl. 26), 67–84.

Blurton Jones, N., & Konner, M. J. (1976). !Kung knowledge of animal behavior: Or: The proper study of mankind is animals. In R. B. Lee & I. DeVore (Eds.), *Kalahari Hunter-Gatherers* (pp. 325–348). Cambridge, MA: Harvard University Press.

Brenzinger, M. (2008). Conceptual strategies of orientation among Khwe: From sunrise/sunset bisections to a left/right opposition. In S. Ermisch (Ed.), *Proceedings of the 2nd international symposium on Khoisan languages and linguistics, January 8–12, 2006, Riezlern/Kleinwalsertal* (pp. 15–47). Köln: Rüdiger Köppe.

Chamberlin, J. E. (2002). Hunting, tracking and reading. In J. Brockmeier, M. Wang, & D. R. Olson (Eds.), *Literacy, narrative and culture* (pp. 67–85). Richmond: Curzon.

de Contenson, H. (1949). Empreintes de pieds humains préhistoriques dans la grotte de Niaux (Ariège). *Bulletin de la Société Préhistorique Française, 51*(6), 214.

Crompton, R. H., Pataky, T. C., Savage, R., D'Août, K., Bennett, M. R., Day, M. H., et al. (2011). Human-like external function of the foot, and fully upright gait, confirmed in the 3.66 million year old Laetoli hominin footprints by topographic statistics, experimental footprint-formation and computer simulation. *Journal of the Royal Society, Interface, 9*(69), 707–719. https://doi.org/10.1098/rsif.2011.0258.

Eco, U., & Seboek, T. A. (Eds.). (1988). *The sign of three: Dupin, Holmes, Peirce*. Bloomington: Indiana University Press.

Franklin, N. R., & Habgood, P. J. (2009). Finger markings and the Willandra Lakes footprint site, South-Eastern Australia. *Rock Art Research, 26*(2), 199–203.

Gagnol, L. (2013). Identifier, rechercher et surveiller par les traces: Éléments d'analyse d'un savoir-faire pastoral dans les sociétés saharo-sahéliennes. *Technique & Culture, 61*, 166–187.

Gagnol, L., Mounet, C., & Arpin, I. (2018). De la piste animal aux lignes de désir urbaines. Une approche géoichnologique de la trace. *L'Information géographique, 82*(2), 11–38.

Hollmann, J. (2005). Using behavioural postures and morphology to identify hunter-gatherer rock paintings of therianthropes in the Western and Eastern Cape provinces, South Africa. *South African Archaeological Bulletin, 60*(182), 84–95.

Husserl, E. (1939). *Erfahrung und Urteil. Untersuchungen zur Genealogie der Logik*. Prag: Academia.

Kinahan, J. (2013). The use of skeletal and complementary evidence to estimate human stature and identify the presence of women in the recent archaeological record of the Namib desert. *South African Archaeological Bulletin, 68*(197), 72–78.

Lemozi, A. (1929). *La grotte-temple du Pech-Merle. Un nouveau sanctuarie préhistorique*. Paris: Picard.

Lenssen-Erz, T. (1994). Jumping about - Springbok in the Brandberg rock paintings and in the Bleek/Lloyd collection. An attempt at a correlation. In T. Dowson & J. D. Lewis-Williams (Eds.), *Contested images – Diversity in Southern African rock art research* (pp. 275–291). Johannesburg: Witwatersrand University Press.

Lenssen-Erz, T., Pastoors, A., Ciqae, T., Kxunta, U., Thao, T., Bégouën, R., Biesele, M., & Clottes, J. (2018). Tracking in caves: Reading human spoor in ice age caves with San hunters. In R. F. Puckett & K. Ikeya (Eds.), *Research and activism among the Kalahari San Today: Ideals, challenges, and debates* (Senri ethnological studies 99) (pp. 103–127). Osaka: National Museum of Ethnology.

Lenssen-Erz, T., Pastoors, A., Roth, G., Ciqae, T., Kxunta U., Thao T. (forthcoming) *Animal spoor in prehistoric hunter-gatherer rock art analysed by contemporary hunter-gatherers*.

Liebenberg, L. W. (1990). *The art of tracking: The origin of science*. Claremont: David Philip.

Lockley, M. (1999). *The eternal trail: A tracker looks at evolution*. Reading: Perseus Books.

Lockley, M., Roberts, G., & Kim, J. Y. (2008). In the footprints of our ancestors: An overview of the hominid track record. *Ichnos, 15*, 106–125.

Lowe, P. (2002). *Hunters and trackers of the Australian desert*. Surry Hills: Accessible Publishing Systems.

Marshall Thomas, E. (1988). *The harmless people*. Cape Town: David Philip.

Moriarty, S. E. (1996). Abduction: A theory of visual interpretation. *Communication Theory, 6*, 167–187.

Nankela, A.M. (2017*). Rock art and landscape: An empirical analysis in the content, context and distribution of the rock art sites in Omandumba East and West, Erongo Region Namibia*. Unpublished PhD dissertation, Universidade de Tras-Os-Montes e Alto Douro.

Odora Hoppers, C. A. (Ed.). (2002). *Indigenous knowledge and the integration of knowledge systems*. Claremont: New Africa Education.

Pales, L. (1976). *Les empreintes de pieds humains dans les cavernes: Les empreintes du resau nord de la caverne de Niaux (Ariège)* (Archives de l'Institut de Paleontologie Humaine, 36). Paris: Masson.

Panofsky, E. (1962). *Studien zur Ikonologie. Humanistische Themen in der Kunst der Reanaissance*. Köln: DuMont.

Pasda, C. (2013). Zu Fuss – Spurenfossilien des eiszeitlichen Menschen. In A. Pastoors & B. Auffermann (Eds.), *Pleistocene Foragers: Their culture and environment: Festschrift in honour of Gerd-Christian Weniger for his Sixtieth Birthday* (pp. 51–70). Mettmann: Neanderthal Museum.

Pastoors, A., Lenssen-Erz, T., Ciqae, T., Kxunta, U., Thao, T., Bégouën, R., Biesele, M., & Clottes, J. (2015). Tracking in caves: Experience based reading of Pleistocene human footprints in French caves. *Cambridge Archaeological Journal, 25*(3), 551–564.

Peirce, C. S. (1955). *Philosophical writings of Peirce* (J. Buchler, ed.). New York: Dover.

Polanyi, M. (1966). The logic of tacit inference. *Philosophy, 61*(155), 1–18.

Reel, S., Rouse, S., Vernon, W., & Doherty, P. (2010). Reliability of a two-dimensional footprint measurement approach. *Science and Justice, 50*, 113–118.

Robbins, L. M. (1985). *Footprints: Collection, analysis, and interpretation*. Springfield: Charles C. Thomas.

Sands, B., Chebanne, A., & Shah, S. (2017). Hunting terminology in ǂHoan. In A. M. Fehn (Ed.), *Khoisan languages and linguistics proceedings of the 4th international symposium July 11–13, 2011, Riezlern/Kleinwalsertal* (pp. 185–214). Köln: Rüdiger Köppe.

Schütz, A., & Luckmann. T. (1975). *Strukturen der Lebenswelt*. Darmstadt: Luchterhand. English edition: Schutz, A., & Luckmann, T. (1973). *The structures of the life-world*. Evanston: Evanston Northwestern University Press.

Stander, P. E., Ghau, I. I., Tsisaba, D., OMA, I. I., & ǁ UI. (1997). Tracking and the interpretation of spoor: A scientifically sound method in ecology. *Journal of Zoology, 242*, 329–341.

Thackeray, J. F. (1983). Disguises, animal behaviour and concepts of control in relation to rock art of Southern Africa. *South African Archaeological Society Goodwin Series, 4*, 38–43.
Webb, S. (2007). Further research of the Willandra Lake fossil footprint site, southeastern Australia. *Journal of Human Evolution, 52*, 711–715.
Webb, S., Cupper, M. L., & Robins, R. (2006). Pleistocene human footprints from the Willandra Lakes, southeastern Australia. *Journal of Human Evolution, 50*(4), 405–413.
Wong, P. B. Y., Groot, V. C., & P.de, Fekken, C., Smith, H., Pages, M., Boag, P.T. (2011). Interpretation of polar bear (*Ursus maritimus*) tracks by Inuit hunters: Inter-rater reliability and inferences concerning accuracy. *The Canadian Field-Naturalist, 125*, 140–153.