Visitors' views of human origins after visiting the Cradle of Humankind World Heritage Site

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The Cradle of Humankind World Heritage Site, west of Johannesburg, was designated in 1999 because of its importance as a locality where numerous hominid fossils have been discovered since the 1930s. In this article, responses to questions from a survey of more than 800 adult visitors to the Cradle of Humankind visitor centres are analysed, covering their understanding of the concept of the 'cradle' and their views on human evolution. Findings indicated that 63% of the respondents conceptualised the cradle as the origin or birthplace of humankind, and a similar proportion thought that nowhere else could be called the Cradle of Humankind (77% of people of South African nationality thought this). Nearly 60% of respondents accepted that humans evolved from an ape-like ancestor, while 25% disagreed. South Africans were less likely to accept human evolution than their international counterparts. The great majority of participants who accepted human evolution based their agreement on various forms of evidence and their knowledge of evolution. A religious foundation was used for their rationale by 60% of those who rejected evolution, with 33% citing evidence for their rejection. The implications of the findings are discussed in the light of public awareness and human origins.

Introduction

It is widely accepted amongst biologists and biology educators that evolution is a crucial organising principle on which much of the field of biology is based.[1] Despite this conviction, there is considerable evidence that public non-acceptance of evolution holds sway in many countries because of a combination of religious beliefs and difficulties in understanding the principles on which the theory rests. Studies demonstrate that considerable proportions of the population hold cultural and religious views which they consider exclude their acceptance of the theory of evolution.[2] Similarly, studies show that the concepts of variation, inheritance, natural selection and descent with modification are difficult to understand, even when explicitly taught in school.[3,4] In this paper, an analysis of the views of over 800 visitors to the Cradle of Humankind is provided. The Cradle of Humankind is a World Heritage Site designated in 1999, which is home to a large proportion of the world's fossil hominids (the revised classification 'hominins' is not used here).

The research findings described in this paper are significant for South Africa for a number of reasons. Firstly, 'African Origins' is a focus area of the Department of Science and Technology which covers interdisciplinary research programmes in palaeontology, archaeology and genetics, and includes the evolution of humankind. The findings will inform such programmes, so that they can be more carefully tailored to the existing knowledge of the public, rather than relying on surveys from overseas. The notion of a 'Cradle of Humankind' relates both to Africa as the birthplace of early human ancestors (early hominids) as well as the birthplace of modern humans. How such a concept of 'birthplace' has crossed from the scientific community to the general public is worthy of examination – is it taken literally or is it used as a metaphor? Secondly, new fossil finds continue to be made in the Cradle. Understanding what visitors think about human origins is important in this process and the insights described in this paper provide valuable background material for public engagement. There are no studies in South Africa on the views of adults concerning human origins, a gap which the paper fills. Thirdly, the survey undertaken in the paper identifies some of the numerous misconceptions which visitors possess with respect to human evolution. Addressing such misconceptions should be one of the roles of the visitor centres in the Cradle of Humankind.

The research questions that the study examined are:

- How do visitors to the Cradle of Humankind understand the term 'cradle'?
- To what extent do visitors to the Cradle of Humankind accept the concept of human evolution, and how do they rationalise their view?

A conceptual model inspired by researchers in the field of evolution in the museum context was used during data analysis.[5,6] This model is based on reasoning patterns of visitors giving explanations of their verbal responses to interview questions about the evolution of organisms, and was originally devised as a tool for both teachers and researchers in the field of evolution.[5] The model was adapted for the purposes of this study and replaces 'reasoning' with 'rationalising statements' for two reasons. First, unlike the museums which were part of the Evans et al.[5] research, the Cradle of Humankind visitor centres do not explicitly 'teach' an understanding of the process of evolution. Secondly, the data collected were in the form of written responses, rather than reasoning during verbal interviews.

Context of the study

Prior to 1994, the South African political system was based on apartheid ideology. One of the central tenets of apartheid was its adherence to Christian National Education,[7] and by the 1960s, there was no reference to Darwin or evolution in the school curricula. The result was that at least two generations of South Africans were denied access to this important aspect of scientific literacy.[8] Ironically, discoveries of early hominid fossils were being made in the

area that would later become the Cradle of Humankind throughout the 20th century. However, the great majority of the South African population would have had no way of appreciating such discoveries in the unfolding human story, through formal schooling.

The original idea that Africa was the 'birthplace' of humans originated with Charles Darwin, who, based on chimpanzees and gorillas occurring in Africa stated, 'It is somewhat more probable that our early progenitors lived on the African continent than elsewhere'.[9] Although scientists favoured Europe or Asia in the early 20th century, as more fossil evidence was uncovered in south and east Africa, the concept of humans originating in Africa became accepted by most Western palaeoanthropologists.[10] However, the notion of modern humans developing in Africa and migrating to all other parts of the globe[11] is still contested in some quarters.[12] The findings below show how people's notions of 'Cradle' and African origins have crossed into the public domain.

The context of the study is clearly within the field of 'informal environments' and specifically 'designed settings'[13] in which the visitor centre space has been devised to provide information about the palaeontological findings in the area and their significance. While scientific findings have been published from the Cradle of Humankind and elsewhere, literature research for this article has revealed there is a paucity of published research on museum education relating to science in the country. Overseas, the situation is very different. In the informal sector in the USA, Storksdieck and Stein[14] found that approximately half of museum audiences accepted the scientific explanation for human origins compared to only 27% of the national sample. However, creationist views are also often endorsed for human origins, and many museum visitors have difficulty in understanding the processes of evolution and hold alternative conceptions about it.[15] Some small-scale studies have shown that museums can contribute to changing visitors' views about evolution. In their first study, Spiegel and colleagues showed that, depending on the type of organism they were considering, visitors reasoned differently about evolution. Visitors tended to combine evolutionary knowledge with intuitive reasoning or, less often, creationist reasoning.[6] More recently, Spiegel found that a single visit to an interactive exhibition on evolution resulted in small changes in visitors' scientific understanding of evolution, regardless of their existing views towards it.[16]

Scott[17-19] has written extensively on the various ways in which visitors make meaning while visiting exhibitions which explain human origins. She found that visitors' 'entrance narratives'[20] had a strong influence on visitors' perceptions of what the museums were portraying. Current ideas about hominid ancestors are becoming increasingly complex,[21] and how such concepts are understood by museum visitors is of growing importance. Scott[18] suggests that museums are being increasingly challenged in the ways they portray human evolution: they need to provide significant experiences for visitors while at the same time devising novel approaches to explain the theories, methodologies and evidence from new hominid evidence from the field. Such learning in informal settings might include aspects of the characteristics of science, such as the tentative nature of scientific knowledge, the status of a theory, and suchlike. Given the very low level of scientific literacy in South Africa[22], designed settings such as the Cradle of Humankind visitor centres need to educate as well as entertain.

Within the Cradle of Humankind, there are two visitor centres open to the public. Maropeng ('returning to the place of origin' in the SeTswana language) provides wide-ranging exhibits for the mostly self-guided visitor. These include earth history, palaeontology, how pre-human ancestors have developed into modern humans, as well as information about human impact on the planet. The centre includes features associated with a theme park, such as a boat ride twisting through an artificial cave and a walk across a rotating tunnel (the 'vortex') representing the formation of the universe. In contrast, the Sterkfontein Visitor Centre provides a smaller museum section showing human ancestral development, and a guided tour through underground caves from which hominid fossils have been excavated. Sterkfontein does not include the features of a theme park found at Maropeng. The official website of the Cradle of Humankind (maropeng.co.za) cites the main purposes of the facilities as being for tourism development, protection and management of the excavated heritage sites and for scientific research. Although there is no explicit link to education, both visitor centres play host to thousands of schoolchildren annually during school excursions.

Method

The approach adopted for this study was a post-visit only design because it was not an impact evaluation. Instead, it aimed to capture participants' views of two aspects of human origins within the context of a visit to the Cradle of Humankind. Data collection consisted of a survey using continual ask sampling,[23] where visitors were intercepted by a researcher as they exited the centre and invited to participate in the study. This type of sampling is considered best practice in informal learning contexts, and can be regarded as a close approximation to a random sample.[24] Once they had agreed to participate, the individuals or pairs completed the questionnaire themselves. The surveys were conducted over 19 days between April and July 2013. Data logs of refusal rates were kept, and using total ticket sales for each day, it was calculated that the data collected ($n=437$ at Maropeng; $n=374$ at Sterkfontein) represented a mean 16% (SD=7.1) of daily visitors. The sample was not representative of the South African population, but was a self-selected group of individuals and groups who decided to visit the Cradle of Humankind.

A questionnaire was developed using questions designed to elicit responses from visitors, based on ideas developed by Scott[19], as well as other evaluative tools such as those of Falk and Storksdieck[25]. The first section of the questionnaire asked demographic questions: age, gender, occupation, nationality and the type of group the visitors were in. An optional question on 'ethnic background' was included. The term 'ethnic background' was chosen as a signifier for 'population group' which is used by Statistics South Africa in its census surveys. Affirmative action policies are current in South Africa society, and statistics on race/ethnicity are kept for redress purposes. A questionnaire was used for pragmatic reasons, in order to survey the largest number of visitors in a relatively short time period without inconveniencing them too much. An interview would have taken more of their time and the refusal rate would likely have been higher, although richer data from fewer participants would probably have resulted. It is accepted that questionnaires have their weaknesses. These include non- or partial-completion, untruthful completion, bias or lack of thoughtfulness in who completes them and so forth.[26] Both Scott[19] and Dickinson[27] noted the limitations of collecting survey data in informal settings, but in the current study, the advantage of collecting a snapshot of over 800 visitors' views was considered fit for purpose.

The questionnaire was face- and content-validated by two experts in evolution education, and piloted prior to data collection commencing. Adjustments were made to the questions, so that they were regarded as valid for the purpose of the study. Ethical clearance for the study was obtained from the Human Research Ethics Committee (Non-Medical) of University of the Witwatersrand (Protocol number 2013ECE019S); all participants were provided with information sheets and they signed consent forms.

In this article, participant responses to three questions from the questionnaire were examined. Questions 8 and 9 asked about the term Cradle of Humankind: why the area had been given this name, and what other area could be so called. This question was developed for two reasons. The first reason was in relation to the question that Scott[19] asked of museum visitors: 'Do you think of Africa as the Cradle of Mankind?' The second reason was to determine participants' contextual understanding of the term 'cradle', the rationale for its use, as well as their knowledge about early human ancestors elsewhere (e.g. east Africa).

Question 10 was, 'Do you accept that humans evolved from an ape-like ancestor? Y/N; explain your thinking in giving this answer'. This was devised to ascertain the visitors' views on human evolution, and was worded to try to avoid the notion of 'belief'. However, 'evolved from' and 'ape-like ancestor' are loaded terms and tend to elicit a response

informed by the visitors' entrance narrative rather than anything they experienced during their visit.[19] General usage of the term 'ancestor' refers to a predecessor of current living persons, and is likely to be interpreted as such by participants. Biologically, 'ancestor' refers to a progenitor, from which an organism has developed or descended. The formulation of question 10 was difficult; Media24[28] used the phrase 'developed from previous species of animals' (the original question was in Afrikaans). The Pew Research Center[29] used the phrase 'humans and other living things have evolved over time', but this does not get to the heart of the issue regarding what humans evolved *from*. So, despite its flaws, question 10 was asked in the form shown.

A quantitative analysis was conducted using frequency counts (descriptive statistics). Where multiple answers were given by the same respondent, the first answer given was used in the analysis, except where indicated below. All inferential statistical findings discussed below used the chi-squared test. Qualitative analysis of the open-ended responses to Questions 8 and 10 were coded inductively.[30] In question 8, a hierarchy of codes was established, whereby, for example, human (humankind, mankind, man etc) >hominid>fossil>skeleton, so that if a respondent referred to human and fossil and skeleton in their answer, it was coded *human*. Inter-coder reliability is important in coding open-ended questions from questionnaires.[31] Reliability was established by getting a second coder to recode the data using a codebook. A randomly selected 10% of the second coder's data indicated an inter-coder reliability of 75% (Cohen's kappa = 0.75), which indicates good agreement.

Rationalising statements derived from the Spiegel and colleagues' conceptual model[16] used during analysis of the qualitative data, are shown in Table 1. To exemplify how the model was used, the right hand column shows an example of each rationalising statement in response to Question 10 in the questionnaire. The statements are used as categories of responses, while the data covered in the findings reflect the responses made by the participants themselves.

Findings

Sample

Broad demographic characteristics of the visitors were as follows: 49% of the visitors were in their 20s or 30s, and 27% in the 40–60 age range. Of the sample, 45% were women, 40% men, 8% completed the questionnaire as a couple, while 7% did not state their gender. Of the visitors, 64% were from South Africa, 12% from the Americas, 11% from Europe, 5% from Asia, and 3% each from Oceania and Africa. Most of the visitors (40%) were part of a family group, while 25% were couples, 12% were individuals, 11% were part of a tour group and the remainder were friends or colleagues. Of the sample, 73% followed a professional career, 8% were students, while the remaining 19% did not state their occupation. The optional question on ethnic origin was answered by 72% of participants, and of those who did, 62% were white, 24% were black and the remainder were of Indian (9%) or Asian (2%) descent or mixed race (2%).

Question 8 read as follows: 'The area of Gauteng/North West Province in which Maropeng lies is sometimes called the 'Cradle of Humankind'. Why do you think it is called this?'

Of the 659 responses to Question 8, 63% referred to the 'origin' or 'birthplace' of 'humans', 'humankind' or 'mankind' (see Table 2). The following quotations are a selection of responses to the question (index numbers in brackets refer to codes of individual quotations, together with some demographic information):

- 'Humankind started here' (1/5 22: South African female; 50s)
- 'The birthplace of mankind – our common birthplace' (1/5 32: French female; 50s)
- 'Because this is where most human remains have been found of the early human beings' (1/5 13: South African female; 20s)

One would expect these sorts of answers, as the meaning of the term can be deduced from the words 'Cradle of Humankind'. Only a few participants (about 1%) expressed scepticism about the name 'Cradle'. For example:

- 'Wishful thinking/marketing – the actual origins of humankind is surely not so precisely known' (11/5 16: British male; 40s)
- 'Fanciful claim based on the finds in several local caves' (26/5 38: Australian male; 70s).

While the majority of participants referred to the concept of the cradle being the origin of humankind, 11% pointed to the presence of hominid fossils in the area, and a further 10% used the term fossil, but did not specify what sort of fossils had been found. Small proportions used the term 'skeleton' (3%), *H. sapiens* (2%) and 'ancestor' (1%) without also including the term 'human', 'hominid' or similar.

There was no statistically significant relationship ($p=0.379$) between the answers to Question 8 and whether or not participants accepted human evolution (Question 10). However, those respondents who accepted evolution were significantly statistically more likely to refer to 'hominids' (13%, $p<0.05$) in their answer to Question 8 than respondents who did not accept evolution (6%, $p<0.05$). One might speculate that the latter were less familiar with the term hominid, or they were less

Table 1: Conceptual model of rationalising statements

Rationalising statement	Description	Example of response
Naturalistic evidential	Any reference to evidence or similarities	'The fossil record combined with DNA evidence combined with anthropological research is hard to argue with.'
Naturalistic evolution	Reference to evolution only, but not to evidence	'I just believe in the theory of evolution and the fittest will survive.'
Naturalistic scientific	An appeal to 'science' or 'logic', without further explanation	'There is no better proved theory that explains the origins of humankind. Such a theory is logical and realistic.'
Creationist religious	Rationale refers to religious belief (God, Allah, Bible, etc.)	'God created man and animals, one did not evolve to the other.'
Creationist evidential	Rationale discusses evidence but does not refer to religion overtly	'Because humans are not evolving still. I see no evidence of this. We remain human!!'
Mixed rationale	Uses a combination of naturalistic and creationist statements	'Science as seen here indicates that there was evolution. The bible says God creates man.'

accepting of hominids as human ancestors when discussing the Cradle of Humankind.

Table 2: Frequency of codes for participants explaining the name 'Cradle of Humankind' ($n=659$)

Codes	Frequency %
Human	63
Hominid	11
Fossil	10
Other	4
Skeleton	3
Origin of us	3
Origin of life	2
Sapiens	2
Ancestor	1
Sceptical view	1

Question 9 reads: 'To your knowledge, is there anywhere else that is or could be called the Cradle of Humankind? (Yes/No). If you answered "yes" to Question 9, Where is it? Why is it called the Cradle of Humankind?' In answering the first part of this question ($n=811$), 63% of the participants thought that there was *nowhere else* that is or could be called the Cradle of Humankind. Only 22% of respondents considered that there might be another place which could be so named (while 15% did not answer the question). These figures suggest that the respondents were unaware of claims to the name which could be made by both Kenya and Ethiopia. Of those who answered the question ($n=612$), there was a statistically significant relationship between respondents being aware of 'another Cradle' and nationality (chi-squared $p=0.000598$; effect size Cramér's $V=0.197$, i.e. low to medium). South Africans ($n=397$) were more likely to *disagree* with the statement ('no' 77%), while Americans, the next highest regional grouping who completed the survey ($n=77$), showed a significantly lower frequency of disagreement ('no' 60%). Although non-South African Africans were few in number, the majority (10/15) agreed with the statement.

Of the small number of participants ($n=135$) who suggested where else a Cradle of Humankind might be, 56% referred to east Africa or one of its constituents (Kenya, Ethiopia or Tanzania), while a further 15% listed 'Africa' or another African country (e.g. Chad, Nigeria). Just over 10% mentioned another part of South Africa, while a few respondents cited the Middle East, Far East or Europe. While some of these areas might be guesses, a minority of the visitors to the Cradle of Humankind were aware of other areas of Africa and the world which are prominent in the study of human origins.

There were three other items of interest in the responses to Questions 8 and 9. A total of 15 respondents (2%) appeared to conflate the notion of the 'origin of humankind' with the 'origin of life', as they used terms such as the following in answer to Question 8:

- 'This is the place where we have found evidence of origin of life' (18/5 21: Indian female; teenager)
- 'It's the place where life originated' (2/6 25: South African female; 20s)

Others talked about the cradle as the place where 'it' all started:

- 'Where it all began' (26/5 40: South African female; 30s & 2/6 27: South African male; 20s)
- 'It's where everything started' (14/7 3: South African female; 30s)

Although the questionnaire instrument did not allow for elaboration of these responses, the responses suggest that these participants do not distinguish between the origin of humans and the origins of life. This misconception has implications for how such issues are presented at museums and visitor centres, and is discussed below.

A total of 5 respondents referred to the Out of Africa (OOA) theory, which states that anatomically modern humans evolved in Africa and spread from there throughout the world. One of the exhibits at Maropeng Visitor Centre explains this, and contrasts it with the Multiregional Theory for human development. However, 'Out of Africa' is a vague notion, and may refer either to OOA I, in which early hominids spread across the world, as cited by this respondent: 'This is where the first hominid stood up and started its journey toward Asia and Europe' (1/5 31). Alternatively, OOA II refers to the spread of modern humans, thus: 'It is where we, modern humans are believed to have developed and migrated from' (1/5 83: British male; 60s).

Considering that 25% of the participants did not accept that humans evolved from an ape-like ancestor (see below), only four people discussed 'creation' in their response to Question 8 or showed scepticism towards evolution. The paucity of discussion of creation and scepticism towards evolution suggests that the great majority of respondents do not dispute the cradle narrative of human origins, hominids and fossils. This may result from the structure of the questionnaire, which asks relatively uncontroversial questions to this point. Once the term evolution was introduced in Question 10, non-acceptance of scientific explanations of human origins became more outspoken.

Question 10 in the survey was, 'Do you accept that humans evolved from an ape-like ancestor?' Y/N; Explain your thinking in giving this answer. Of the respondents, 59% ($n=811$) accepted the concept, 25% disagreed, while 16% did not state their opinion or gave another answer.

There were no statistically significant relationships between acceptance of human evolution and gender, age or occupation (confidence levels were set at 95%). Of the respondents who stated their nationality and answered the question ($n=705$), there was a statistically significant relationship between acceptance of evolution and nationality ($p<0.00001$; effect size medium: Cramér's $V=0.221$). Although more South Africans agreed than disagreed with the statement, this figure (59%) was significantly lower than expected ($p<0.001$), and their disagreement (37%) was higher than expected ($p<0.001$). Significantly more people from the Americas and Europe agreed (89%, $p<0.001$), with fewer than 10% disagreeing ($p<0.001$). The data are shown in Table 3, and suggest that the South Africans who participated in the

Table 3: Percentage acceptance of human evolution by nationality ($n=705$)

	South Africa	Americas	Europe	Asia	Oceania	Africa (non-South African)	Multiple
Yes	58.6	89.2	89.5	70.3	100.0	55.0	86.7
No	37.4	7.2	9.2	29.7	0.0	40.0	13.3
Other	4.0	3.6	1.3	0.0	0.0	5.0	0.0

survey are less likely than their international counterparts to accept human evolution. Possible reasons for this will be investigated in a later phase of the study involving interviews.

As shown in Table 4, of those who stated their ethnic background ($n=578$), there was a statistically significant relationship between acceptance of evolution and population group ($p=0.0015$), though the effect size was small (Cramérs V=0.145). Compared to the other groups, black participants were significantly less likely to answer 'yes' to the question (44% $p<0.001$), and significantly more likely to *not* answer it (20% $p<0.001$). These data suggest that black South Africans are less accepting of human evolution than other population groups. This may be related to religious beliefs[32] not explored here, and will be investigated further by interviewing participants. Although the data from both Tables 3 and 4 were affected by sampling, interviews will also be able to determine the interest shown in the Cradle of Humankind by people who do not accept evolution.

Table 4: Percentage acceptance of human evolution by population group ($n=578$)

	White	Black	Indian	Asian	Mixed race	Hispanic
Yes	63.6	43.8	69.2	66.7	83.3	80
No	24.7	29.9	17.3	25	16.7	0
Not answered	8.9	20.4	13.5	8.3	0	0
Other	2.8	5.8	0	0	0	20

In their study of 32 visitors to the Explore Evolution exhibition on display in Midwestern museums in the USA, Spiegel and colleagues[6] found that their respondents used mixed patterns of reasoning to explain evolutionary events. In the current study, the most interesting answers in the questionnaire came from the participants' responses to Question 10: 'Explain your thinking in giving [your] answer'. A total of 68% ($n=551$) of the respondents gave an explanation, and the following findings refer to that proportion of the participants who responded, recalculated to 100% (see Table 5). The respondents' explanations fell into the two clear groups of agreement or disagreement, with some expanding on their 'maybe' or 'yes and no' answers. Both groups contained examples of misconceptions in their statements.

Of those who agreed with the statement ($n=362$) in Question 10, the largest combined category (47%, $n=171$) was the respondents who cited various forms of evidence to back up their assertion. This included anatomical, genetic, fossil, and behavioural facts in support of evolution, for example:

- 'The ape-like ancestors had many physical features that evolved into current human species – based on mode of erect mobility and use of the 'thumb'' (2/6 30: South African female; 60s)
- 'Genetic makeup is similar to man' (11/5 28: South African female; 30s)
- 'Fossils give an indication as to where we evolved from' (16/6 26: South African female; 20s)
- 'We resemble many behaviours of theirs' (9/6 23: Indian male; 20s)

Some of these explanations cited 'similarities' between humans and apes (or ape-like ancestors), but did not specify what such similarities are, for example:

- 'similarity in looks' (18/5 10: Indian female; 20s)
- 'It has always been in my mind as to why the resemblance was so much!' (13/7 38: South African male; 20s)

The next largest category (27%, $n=96$) was those respondents who referred to evolution in their explanation. Comments ranged from simple one-word answers or phrases: 'Evolution', 'Origin of the species' to more detailed explanations covering beliefs:

- 'I believe in the theory of evolution' (1/5 71: South African male; 40s)

And elements of reasoning:

- 'If you look at apes today you can still see in some ways how they have evolved to become humans – just how time progressed and evolution set in' (misconception; 2/6 32: South African female; 20s)

Other explanations referred to evidence, but did not actually specify what the evidence was, for example:

- 'Evidence' (1/5 1 & 9/6 8: both South African male; 30s)
- 'The evidence overwhelmingly points in that direction' (1/5 86: Irish male; 30s)

Of the explanations, 18% ($n=64$) appealed to 'science' or 'logic', with little further explanation. For example:

- 'Scientific evidence' (11/5 26: Tanzanian male; 30s & 14/7 41: South African female; 40s)
- 'Because it is logical' (9/6 31: South African female; 20s)

Of those respondents whose explanation did not agree with the statement ($n=150$), 60% ($n=90$) cited a religious rationale for their view. The most common explanation by these respondents was of God as creator, for example:

- 'God created us' (14/7 20: South African family group)
- 'God created everything' (16/6 12: South African female; 40s)
- 'We were all created by an all-powerful being. GOD' (1/5 47: South African male; teenager)

Table 5: Percentage of responses based on the conceptual framework using rationalising statements

Rationalising statement	Evolution acceptors	Evolution rejecters	Unsure
Naturalistic evidential	47		0
Naturalistic evolution	27		0
Naturalistic scientific	18		0
Creationist religious		60	0
Creationist evidential		33	0
Mixed rationale	1	3	7
Other	8	1	0

The next most common explanation by these respondents was a statement that they do not accept evolution (5%), for example:

- 'I am not convinced' (14/7 6: South African male; 70s)
- 'There is no proven link in evolution theory' (13/7 30: Mauritian male; 40s)
- 'We are special' (14/7 30: German male; 50s)

Along similar lines, some of the disagreeing respondents appealed to the Bible as the source of authority. For example:

- 'Bible says NO to evolution' (16/6 35: South African family group)
- 'I am a Christian and believe the Bible is the truth and God created us as human beings' (1/5 38: Asian couple)

A total of 33% of the respondents who disagreed with the statement ($n=50$) cited some form of evidence or argument for creationism. Some examples of these explanations are:

- 'Don't believe in evolution. Believe that an ape is an ape, human being is a human being – cause all this things I have seen there, there is no full evidence to convince me. God is a creator.' (18/5 4: South African teacher accompanying school excursion)
- 'When God created man, he wasn't confused and started with a Ape. Why there aren't there and half ape half human species today?' (misconception; 1/5 39: South African male; 40s)

A mixed rationale was used by a small number of those who agreed or disagreed with the statement, and 7% of those who said they were unsure. Examples of such reasoning are:

- 'I think there must be evolution, but why don't we have half-ape people running around now? Have we no stopped evolving?' (misconception; 8/6 14: South African male; 20s)
- 'Yes – the genetic evidence and bodily structure proves the theory. No – people do accept the Adam & Eve theory' (16/6 23: South African male; 30s)

Discussion

The findings presented above represent a self-selected sample of people interested enough to visit the Cradle of Humankind. While there are no clear indicators of numbers of museum visits by South Africans, there is a healthy domestic tourism industry with 25 million trips taken in both 2012 and 2013[33] which suggest that the sample surveyed can provide baseline data for future surveys.

The sample answers to Question 8 show how misleading the term 'Cradle of Humankind' is to visitors. While it is a useful branding tool for tourism purposes, it promotes a misconception about the origins of *Homo sapiens*. The current scientific consensus suggests modern humans originated in East Africa. It would appear that the proclamation of the Cradle of Humankind as a World Heritage site in 1999, and its subsequent promotion in South Africa, has strongly influenced the visiting South African public such that they consider it has the only claim to the name. From a scientific viewpoint, it is recommended that the Maropeng and Sterkfontein Visitor Centres need to situate the World Heritage Site within a broader African context, so that the visiting public understands two issues more clearly. Firstly, different species of early hominids were found throughout the African continent and may have overlapped in both space and time. Secondly, the earliest *Homo sapiens* fossil specimens were found in East Africa 160 000 to 120 000 years ago, rather than in the Cradle of Humankind in South Africa.

Questions 8 and 9 suggest that a small number of participants (2%) appear not to discriminate between the origin of humans and the origins of life. Such a notion would appear to be related to the concept of 'deep time' which is difficult for the layperson to comprehend. Both of the visitor centres attempt to explain geological time scales but a visitor's cursory glance at such an exhibit is unlikely to be internalised. Deep time is a crucial concept in evolution, therefore, it is recommended that the visitor centres find ways to make visitors engage with the idea.

The findings from Question 10 show that 59% of the South African respondents accepted the concept of human evolution, while 37% disagreed. A South African online survey in 2014 ($n=1002$) found an evolution acceptance rate of 49% for the statement 'Humans developed from previous species of animals'[28]). These surveys suggest that the South African public's acceptance of human evolution is lower than the 59% from visitors to the Cradle. There are a number of surveys on evolution conducted around the world, and it can be instructive to compare the findings from the current study with them. The 59% acceptance rate from the current survey is in line with a 2009 survey (sample size and selection criteria unknown) which found that 54% of the South African public accept 'that it is possible to believe in a God and still hold the view that … human life evolved … as a result of natural selection' (figures for Great Britain and Egypt were 54% and 45% respectively). However, only 6% South Africans accepted that 'life on earth, including human life, evolved over time … God played no part' (Great Britain 38%; Egypt 2%), and 43% consider that life 'was created by a God and has always existed in its current form' (Great Britain 16%; Egypt 50%).[34] The Pew Research Centre[29] found in 2013 that 60% of American adults ($n=1983$) agree that 'humans have evolved over time'. In the current study, the proportion of South African respondents who reject evolution is in line with the Pew percentage (37% vs 33%), while those who didn't answer is higher (16% vs 7%). Other studies have found that visitors to museums are more likely to endorse evolution as the explanation of human origins compared with the general public.[14] Given the self-selected sample of the current study, the findings do not represent the views of the South African population, but they provide baseline data for future possible comparison within a relatively educated segment of the population (as indicated by their occupation).

The rationalising statements of the participants who accepted human evolution (naturalistic evolution) suggest that the majority of them (74%) used their knowledge of scientific evidence and evolution to back up their conviction. While the extent of their knowledge was not probed, the findings suggest that these visitors were aware of some of the evidence for evolution. Other 'acceptors' (18%) appeared to rely on the status of science or logic as a rationale for their view (naturalistic scientific). One of the implications of this is that the visitor centres should aim to present clear evidence for human evolution, which might enable the visitors to clarify their own interpretations of the issue.

In contrast to the majority of evolution acceptors, only 33% of the non-acceptors cited evidence to support their disagreement with the statement (creationist evidential). The majority (60%) appealed to their own absolutes such as God as the creator, and the Bible as truth (creationist religious). This suggests different ways of thinking between the two groups, with those who agreed with human evolution citing evidence, while those who did not agree using religious-based statements. Gould[35] suggested the principle of NOMA, or 'non-overlapping magisteria' in which both science and religion each have legitimate domains of teaching authority. This might be a possible option that the visitor centres could adopt: presenting the science of human evolution, while also acknowledging that believers have religious views which need to be acknowledged. By presenting the views of faith groups alongside the scientific narrative, Maropeng and Sterkfontein could encourage visitors to think more deeply about the issues involved, and stimulate debate and discussion.

The responses from both the participants who accepted and those who rejected human evolution contain numerous misconceptions. Two examples will suffice here: humans evolved from apes or monkeys; humans are not evolving. These mirror more general misconceptions about evolution found in the literature[36] and indicate that if the visitor centres aim to provide more than a tourist experience, they need to actively identify the commonest misconceptions, address them, and ensure that guides are well-versed in changing visitors' misconceptions. This is particularly important in the light of the large number of school students who visit the Cradle of Humankind.

Conclusions

The majority of the sample of visitors surveyed understood the term 'cradle' as an origin or birthplace of humankind. Although the instrument used was only able to access their knowledge at a fairly superficial level, the fact that over 84% of participants referred to humans, hominids or fossils suggests that they possessed some general knowledge of human ancestor fossil remains. However, 63% of the visitors surveyed appeared to be unaware that there are other areas of the world which potentially have better claims to the title 'Cradle of Humankind'. This unfamiliarity was particularly prevalent amongst South African visitors, and suggests that the visitor centres need to show that the area is one of several sites important for early human ancestors. Such provision of information would assist in making the public more aware of the tentative nature of scientific knowledge; that science itself is continually evolving rather than being a fixed body of knowledge. This is a goal of scientific literacy programmes internationally.[37]

The concept of deep time is one which most visitors are likely to be unfamiliar with, yet it is crucial for understanding the process of evolution. Additional visitor centre exhibits engaging visitors with the concept would likely assist visitors to comprehend this difficult idea.

Nearly 60% of the sample of visitors accepted that humans evolved from an apelike ancestor, while 25% did not accept this. There were statistically significant relationships between acceptance and nationality, and acceptance and population group, suggesting that South African visitors are less accepting of human evolution than their international counterparts. This has implications for the visitor centres as over a third of South Africans do not accept human evolution, yet this is the dominant narrative of the exhibits. In terms of the conceptual framework, the findings show that 'evolution acceptors' use different rationalising statements (i.e. evidence) from 'evolution rejecters' (i.e. religion). In order to promote deeper thinking about human origins, maybe the centres should juxtapose scientific explanations of human origins against religious explanations. The current scientific debates about the various possible human ancestors could also be presented, as well as examples of the compatibility between religious belief and acceptance of evolution.

Finally, one of the purposes of museums and visitor centres is to encourage visitors to think differently about things. Getting people to think through their own beliefs needs to be made more explicit if visitor centres in the Cradle of Humankind are to make a greater impact on the scientific literacy of the South African public.

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