An interactive exhibition about animal skeletons: did the visitors learn any zoology?

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There are few studies concerning museum visitors' understanding of skeleton exhibits and whether such exhibits increase their understanding of the zoology displayed. An exhibition focused on the diversity of vertebrate skeletons and arranged according to the mode of locomotion was set up in Naturalis, the National Natural History Museum of The Netherlands, in Leiden. A prototype explaining the principal components of the skeleton was designed for each type of locomotion, for example, wrigglers, flyers, walkers, crawlers, swimmers. In addition, a panel provided in front of the exhibit case for each type of animal locomotion could be touched with an artificial bone at the appropriate place in order to activate miniature lights that corresponded with specific parts of the skeleton. At first visitors did not always understand the use of the artificial bone. However, many visitors, after reading the introductory text panels, knew what to do and used the exhibition in a very interactive way. Interviews and observations indicate that the exhibition did increase the zoological understanding of the visitors.

Key words: Skeletons, Visitors' zoological knowledge, Museum.

Introduction

The significance of the endoskeleton in chordate biology is of primal importance. It is studied in many science curricula from the earliest years. However, comparatively few studies have investigated pupils' knowledge about animal skeletons (Driver *et al.*, 1994). Furthermore, such work has been done mainly on human skeletons (Gellert, 1962; Williams, Wetton and Moon, 1989; Osborne, Wadsworth and Black, 1992; Guichard, 1995; Cox, 1997). Work on the skeletons of other species has involved a range of interventionist methodologies. In particular, Caravita and Tonucci (1987) and Caravita (1996) presented seven-, nine- and 12-year-old Italian school children with a variety of activities designed to explore their understanding of the structure and functioning of parts of the skeleton. After pupils dissected a rabbit's leg, they went on to build a model of the leg, relating structure to function. The most thoroughly studied organ system and the knowledge of pupils of what is inside themselves, which has been revealed by drawings, is the human skeleton (Caravita and Tonucci, 1987; Guichard, 1995; Cox, 1997; Reiss and Tunnicliffe, 1999).

There is very little work that systematically and quantitatively examines knowledge of vertebrate skeletons amongst the public or indeed amongst school pupils. Published work and teaching observations suggest that children have only 'unit' knowledge of parts of the skeleton (Tunnicliffe and Reiss, 1999). When asked about some skeleton exhibits in a natural history museum in England, and a skeleton on display in a USA zoo, visitors 'clothed' the skeletons they looked at in their minds and talked about the animal they represented, but were limited in their ability to 'read' the skeletons for clues as to the habitat and behaviour of the animals when alive (Tunnicliffe and Yonally, 1999). A study of the response of visitors in a museum to skeletons displayed around the museum showed that if an animal were very similar to human, such as a gibbon, the visitors are much more likely to recognise the skeleton of the animal, firstly as a skeleton and secondly, as belonging to that named animal. If the animal is less like the human form, the visitors name the animal and do not mention the skeleton at all, even though they are in fact viewing the skeleton and not a whole animal specimen (Tunnicliffe, 1998). Younger visitors are more likely to name the animal than are older visitors.

There is no account, to our knowledge, about visitors' responses to a whole exhibition focusing on vertebrate skeletons. We were therefore interested to find out how visitors did respond to such an exhibition and whether the concepts within the exhibition were received and understood by the visitors and if the exhibition increased the zoological knowledge of these visitors.

The exhibition and its rationale

A temporary exhibition, called 'Spare ribs' or, in Dutch 'Niks aan!' was opened at the National Museum of Natural History

Naturalis in Leiden, The Netherlands in July 2000. The aim of the exhibition was to improve the understanding of visitors about the aspects of vertebrate skeletons. There is a strong relationship between the shape of the skeleton and locomotion of the animal. The exhibition focused on the vertebrate skeleton and sought to explain in an interactive and understandable way the relationship between the skeleton and locomotion. The exhibition team decided to arrange the skeletons according to different ways of locomotion. As a result, the diversity of exhibit labels was reduced to a number of basic skeleton shapes that correlate with locomotion types.

For every locomotion type represented, a certain animal species that is representative of the locomotion type was chosen as a model in order to create the prototype. In this way, for example, the dog was the model for the 'walkers' (Figure 1); the pigeon for the 'flyers' (Figure 2); the perch for the 'swimmers' (Figure 3).

In every prototype, the different parts of the skeleton that play a role in locomotion – the fore limbs, hind limbs, backbone, pelvic girdle and shoulder girdle – were given a particular colour on the labels. The result was a set of thirteen different, coloured animal skeletons which were built as small three-dimensional models, and were shown in an exhibit alongside the real skeletons of the exemplary animals.

Skeletons of animals that have similar ways of locomotion were grouped together in the rest of the exhibition. Every group could be recognised by a drawing of the prototype that represented a certain way of locomotion. Each interactive part of the skeleton on the panel in front of the exhibit case was colour coded so that all the skeleton labels had the same colours, but the overall arrangement was different according to the locomotory mode of the group: bipedal walkers, for example, have long hind limbs whilst wrigglers have no limbs.

The visitor could touch the coloured parts in the drawing of the prototype on the panel using a so-called 'pointer bone' (a cast of a bone of a dog or baboon), collected at the entrance of the exhibition, which had a magnet at one end covered by plastic bone.

The tip of the bone completed an electric circuit and numerous small lights lit up the corresponding bones in the skeletons in the exhibit. In this way, skeletal similarity between animals that share the same way of locomotion becomes clear at a glance.

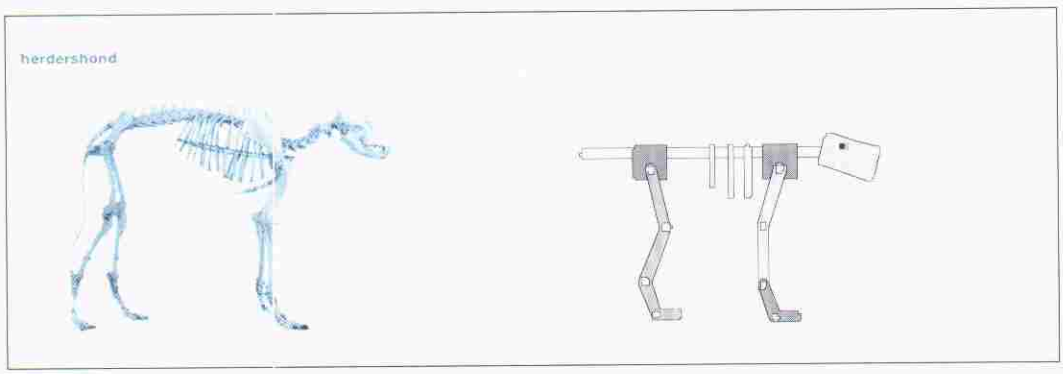

Figure 1 *Prototype of the 'walkers, quadrupeds', deduced from the dog. © naturalis*

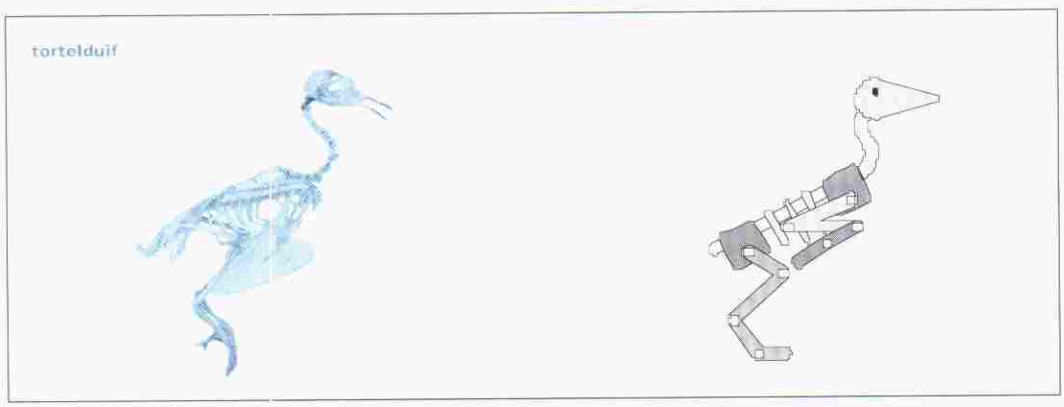

Figure 2 *Prototype of the 'flyers', deduced from the pigeon. © naturalis*

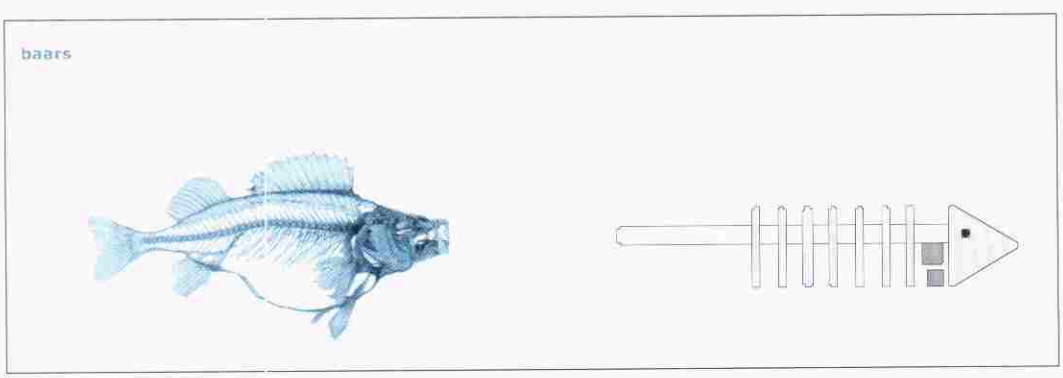

Figure 3 *Prototype of the 'swimmers', deduced from the perch. © naturalis*

Note: The development of the prototypes has been carried out in cooperation with the University of Leiden (biology, department ethological morphology) and they hold the copyright of Naturalis.

Methodology

The museum was interested in the responses of the visitors to the skeleton exhibit, and in particular whether the zoological messages of the exhibition were received and understood by them. It was decided that the conversations of visitors looking at the skeletons would be videoed and interview responses from visitors, both before and after they visited the exhibition, with an emphasis on form and function of the skeletons, would be written down.

Video recording was carried out opposite the skeleton of an elephant and next to a case of 'flyers'. This location was

chosen because there was an alcove in which the researcher could sit with the video camera and not impede the flow of visitors.

A visitor studies student worked on questionnaires. Questions were asked in Dutch, the analysis of which was intended to elicit whether visitors had, firstly, understood, secondly, found out new information from the exhibition and, thirdly, to indicate how much the public responded positively to the exhibition.

The conversations at the exhibits were recorded on the video and subsequently translated. There were 42 audible conversations and 61 different episodes of visitors looking at the skeletons. Each incident was watched and rewatched until the behaviour was clear. Subsequently, the different behaviours displayed by visitors were watched, described and rewatched and then grouped into different categories.

Results

Questionnaire

Sixty-five people were interviewed before they experienced the exhibit and 68 afterwards, of whom 54 were interviewed on both opportunities. Twenty-nine visitors were observed in the exhibit over seven hours. Over ten hours were spent video-recording individuals or groups of visitors looking at the exhibits.

Visitors' responses to skeletons

The average length of stay in the whole exhibition was 20 minutes. Of the visitors observed, 82% picked up a bone at some point in their visit and, of these, 65% did so at the beginning of their visit. There were 65 videoed encounters at exhibits containing skeletons. The different actions of visitors were noted and totalled. Of these, 19 were families, five were adult singletons, 19 were two or more adults and 12 were children alone. Of the 65 videoed encounters, 37 of the groups/individuals used a bone, seven used something else such as a pencil, finger or a torch. Five people used the bone as a pointer and 12 used nothing.

Pre-visit questionnaire: Zoological knowledge

Sixty-three visitors were asked, 'Have you seen a skeleton before?' and, 'If so, what?'.

Sixty visitors remembered that they had done so, two did not know and one said they had not. Of those who had seen a skeleton, 32 recalled a mammal, 20 a bird, 19 recalled a reptile, and of these only 2 skeletons remembered were non-dinosaurs. Two visitors said they had seen too many to remember, whilst some visitors recalled several types of skeleton.

The responses to the question 'How is the skeleton of other animals different from that of a human?' are shown in Table 1.

Post-visit questionnaire

The visitors were asked questions to find out if the message of the exhibit had been understood, at least in part by them. Sixty-eight visitors were interviewed, of which 23 were isolated males, 33 were isolated females, and the rest were male and female couples.

Visitors' comments about the skeletons, made after they had viewed them, are shown in Table 2.

After their visit, visitors were able to cite a few more functions of skeletons (Table 3).

Table 1 'How is the skeleton of other animals different from that of a human?'

Comment	*Number of responses n = 68*
No or little difference	12
4 feet	14
Tail	3
Different bones / wings / teeth	5
Bones are of different material	4
Size (e.g. human smaller/other animals smaller	33
Shape – different or similar	32
Don't know	6

Table 2 Comments about skeletons

Comment	*Number of responses n = 88*
Morphology, e.g. There is similarity amongst skeletons. Some parts of the skeleton are the same in all vertebrates	19
Function of skeleton, different ways of moving are reflected in the skeleton design; every bone has a function	19
Other	29
e.g.	
Exhibit teaches how skeletons are constructed	13
Shows differences between animals	4
Ethical points/aesthetic	10
Skeleton is too scary but beautiful, helps get to know nature better	
Other, e.g. shows us something we normally don't see	11

Conversations at the exhibits

There were 42 audible conversations. These were transcribed and read. A read – reread technique was employed to establish the main categories of content. The categories were:

1. Remarking that they needed a bone
2. Affective comment – 'Like', 'Interesting', 'Wow!'
3. General comments about locations, e.g. 'There are a lot of people', 'When are we going?'
4. Size of the exhibits
5. Instructions and commands, e.g. 'Does it work?', 'Do this?', 'Touch that!'
6. Function of skeleton
7. Naming specific animal or bone
8. A question about exhibit
9. Command other than about using the bone, e.g. 'Look', 'Come here!'

The number of different conversation topics – some conversations included several of the topics – is shown in Table 4.

Many conversations focused on one theme. For example, Conversation 10 was unusually lengthy but still on one theme:

Child: 'Look!'
Mother: 'Yes. Nice! And now to the right, where do you think that goes? Hold it hold it, yes'
Dad: 'No, down, look you can see it here!'
Child: 'Ok I will take it down'
Dad: 'Lower'

This conversational exchange is a series of instructions about using the exhibit through using the bone. In this case, the exhibit technique is the main attraction not the skeleton itself.

The majority of conversations consisted of one exclamation, which was unanswered. For example, a boy said to his sister 'Iona, go away!' and in another example, a boy just said, 'Look!' at a skeleton. Many conversations focused on instruction. For example, a mother asked her child who was operating the bone 'What does that look like? Nils! Those are the feet!' she continued on through the exhibition when the child had failed to illuminate the part she wanted to have done so.

Visitors were asked to tell us what they had learnt about skeletons that they had not known before. Thirty-three visitors said they did not know. Of the remainder (21), nine remarked on the shape of skeletons of different animals. Two expressed surprise that a snake also had bones and that the Tuna fish skeleton is so large. Many comments reflected the surprise of visitors at the similarity in structure of the skeletons; hence these visitors were appreciating the vertebrate pattern.

Table 3 Pre- and Post-visit answers to functions of the skeleton

Before the visit	*After the visit*	*Number of comments n = 18*
Firmness	Firmness	8
Firmness	Firmness, movement	3
Firmness	Firmness, protection, movement	1
Firmness, protection	Firmness, protection	2
Firmness, protection	Firmness, protection, ligaments are attached to the bone	1
Movement	Movement, firmness	1
Movement, firmness, protection	Movement, firmness, shape	1
Movement, firmness, shape	Movement, firmness, shape	1

Table 4 Content of conversations at skeleton exhibits

Category	*Number of comments n = 49*
1. Remarking that they needed a bone	1
2. Affective comment-	6
3. General comments about locations-	6
4. Size of the exhibits	2
5. Instructions and commands-	17
6. Function of skeleton	1
7. Naming specific animal in bone	5
8. A question about exhibit	4
9. Command other than using bone	7

Discussion

The knowledge of zoology amongst most visitors assumed by the exhibit designers was far higher than they possessed. From experience of teaching and research (Tunnicliffe and Reiss, 1999), it is evident that people have little understanding of the skeleton of other vertebrates and the function of parts of the vertebrate skeleton, other than the embracing term 'locomotion'. Perhaps if the exhibition had started with the basic vertebrate plan, followed by the human skeleton and ways in which it moves naturally – walking, running, swimming, crawling, hopping – and then the ways in which humans move with the assistance of technology (flying), visitors would have been led into zoological knowledge through their understanding of themselves. They may also have noticed more similarities between different skeleton arrangements.

Even though the exhibition was splendid and innovative in concept there were some negative points, many of which the museum personnel had discussed during the preparation of the exhibition. The way the exhibit was finally delivered and presented to the public was the result of long negotiations about these issues.

Implications for teachers and educational visits

'Niks aan!' was an exceptional exhibition in terms of the clearly expressed zoology. However, it required a level of pre-visit zoological knowledge and understanding which appeared to be lacking in most visitors. Furthermore, visitors needed to be briefed on the manner in which the exhibition should be viewed and the route to take. The implications for any teacher taking students to such an exhibition is that you need to either make a pre-visit or talk very carefully to the education department at the museum. Teachers could inquire whether there is an orientation section as there was in this exhibition, which helped them to make sense of the exhibits. Moreover, the means of interacting with exhibits needs to be clearly understood beforehand so that inappropriate methods are not tried and time is not wasted in finding out the correct means! The zoology inherent in this exhibit would have been maximised more effectively had visitors had a chance to see the prototypes before their visits – ideal in the case of schools – or at the very beginning, or even outside the gallery, so that they had explantory material immediately before entering the gallery.

Form and function are very clearly linked in this exhibition and pupils would need an understanding of this in order to appreciate the zoology of the exhibition. Teachers would therefore need to be very clear, before visiting the exhibition, of the pupils' level of understanding about:

- the vertebrate skeleton
- different types of locomotion
- the adaptations for locomotion which are apparent in the anatomy of the animal and that may be recognised from external morphology

Notes taken by visitors, or provided by the museum, based on the prototypes would provide an excellent basis for zoology students studying vertebrate morphology and linking form to function. Teachers might like to consider carefully the role such exhibitions can play in developing and consolidating the knowledge of their students to achieve effective meaningful learning outcomes.

The interactive nature of the exhibit, using the bone to illuminate different parts of the exhibit, served as the focus of the interaction rather than the skeletal adaptations. Teachers need to be very aware of the nature of the exhibits that they take

their pupils to see and how they are expected to interact with them. Children would benefit from a period of familiarisation with such exhibits before they then focus on the zoology.

In conclusion

Families at whole animal exhibits recall events related to the animals from their own experiences and comment on salient features (Tunnicliffe, 1995). People at skeleton exhibits say very little (Tunnicliffe and Yonally, 1999) unless questioned. The same pattern was found at 'Niks Aan!'. The exhibition did increase visitors' knowledge of vertebrate skeletons. Whether this information would be retained and developed we are unable to say. However, the exhibition provided a striking aesthetic experience, one that is likely to stay with them for a long time. If such exhibitions were to be used with school groups, a period of familiarisation of the interaction with the exhibit would be required, as well as a sound understanding of vertebrate skeletal morphology and forms of locomotion.

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