The Influence of an Interactive Educational Approach on Visitors' Learning in a Swiss Zoo

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ABSTRACT: A new but costly approach to providing visitors of zoos with information on conservation is the presentation of small exhibits by zoo professionals or volunteers. At these "touch tables" visitors can find out about the biology, ecology, and conservation of animals kept in the zoo. We studied the effect of a touch table on visitors' learning in a Swiss zoo (Tierpark Goldau) using an experimental approach. For half of each day, visitors could choose to gain information from labels next to the enclosures and posters. In addition, for the other half of the day visitors could also choose to make use of a touch table on the bearded vulture (*Gypaetus barbatus*). More than 600 visitors participated in the study. Results revealed that the modern approach was successful. Visitors using the touch table knew more about the biology, ecology, and conservation of bearded vultures, both immediately after their visit to the zoo and two months later. It is suggested that more use be made of touch tables in zoos, museums, visitor centers, and other settings for nature education. *Sci Ed* **90:**296–315, 2006

INTRODUCTION

The accelerating decline in biodiversity due to human activities is one of the most urgent environmental issues (Wilson & Peter, 1988; Meffe & Carroll, 1994). In order to safeguard the richness of life forms globally, it is essential to raise public awareness of the need

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to preserve biological diversity (UNESCO, 1993; WRI & IUCN/UNEP, 1992). The conservation of animals and the provision of nature education are both important tasks of a modern zoo. This is exemplified by the publication, in 1993, of *The World Zoo Conservation Strategy* (IUDZG/CBSG (IUCN/SSC)), which outlines the ways in which zoos and aquaria can contribute to the conservation of wildlife and biodiversity (Hawksworth, 1995). For instance, coordinated breeding programs, with the long-term aim of supplementing wild populations, or re-introducing populations, will play an increasingly important role in zoo strategy, as well as information and education about nature conservation (De Boer, 1992; IUDZG/CBSG (IUCN/SSC), 1993; Hawksworth, 1995).

Zoos serve some 600 million visitors annually, and their potential for making people of all ages aware of the threats to the global ecology and the importance of nature conservation is unlimited (IUDZG/CBSG (IUCN/SSC), 1993). If zoological gardens make use of their enormous educational potential, they will become an important place for nature education (Dierking & Falk, 1994) and can offer an effective contribution to the increase of public and political awareness of the necessity for conservation (IUDZG/CBSG (IUCN/SSC), 1993). Today, many zoos spend considerable time and money in informing their visitors not only about the biology of animals, but also about ecological processes and conservation (see Wineman, Piper, & Maple, 1996; Martin, 1997; Andersen, 1998).

Learning in free-choice learning settings such as zoos, aquariums, museums, science centers, botanical gardens, and libraries is considered to be very effective because people have control over what and how they learn, and because they can choose to learn in appropriate and supportive contexts (Falk & Dierking, 2000). However, people visiting zoos or other informal learning settings are very diverse and include people of all ages and most educational levels (Falk, Koran, & Dierking, 1986; Falk & Adelman, 2003). Some visitors, for instance, have extensive knowledge and skill in science, whereas others have little or no formal science background. Previous knowledge ("what the learner already knows") has been identified as the single most important factor influencing learning (Ausubel, 1968). Successful education is only achieved when the gulf between the level of knowledge and understanding a visitor brings to an exhibit and the messages that free-choice learning settings may wish to communicate is bridged (Tunnicliffe, Lucas, & Osborne, 1997; Falk & Adelman, 2003).

Traditional views of learning basically treat learning as a linear and predictable accumulation of knowledge, as if learning is "a process of filling up identically empty minds as they move past on the educational assembly line" (Falk, 2001, p. 14). However, from a constructivists' viewpoint learning is highly individualistic in nature (Anderson, Lucas, & Ginns, 2003). It is a uniquely personal, contextual experience (Falk, 2001) and a lifelong, cumulative process that has more to do with consolidation and reinforcement of previously understood ideas than with the creation of totally new knowledge structures (Dierking et al., 2003).

Several studies have shown that multiple factors such as age, background, prior knowledge, personal experience, interests, motivation, and the physical environment all interact to contribute to the learners' experience in free-choice learning settings (e.g. Brody et al., 2002; Falk & Adelman, 2003; Falk, Moussouri, & Coulson, 1998; Rahm, 2004; detailed overviews in Falk, 2004; Falk & Dierking, 2000). In such settings, interactions and collaborations with individuals of their group (e.g. family, friends) can strongly influence visitors' learning experience (Borun et al., 1997; Tunnicliffe, 2000). Moreover, high-quality interactions with people from outside an individuals' own social group, e.g. interactions with zoo rangers, guides, or museum explainers, can strongly enhance visitors' learning (Rosenthal & Blankman-Hetrick, 2002). The learners' engagement with physical experiences is also seen as a critical element in learning (Brody et al., 2002).

The more complex the learning issue is, the more effort must be placed on supportive information tools to explain it (IUDZG/CBSG (IUCN/SSC), 1993). A new but costly approach in zoos and other free-choice learning settings to provide visitors with information is the presentation of small exhibits by staff or volunteers. Such exhibits often consist of moveable carts or tables (so called "touch tables") on which objects are placed that are available for visitors to touch, move, and use a variety of senses to inspect them (Koran et al., 1984).

Touch tables may have certain advantages compared to other information tools such as labeled displays. First of all, the mere physical involvement in hands-on activities might increase visitors' feeling of ownership and thus result in a higher satisfaction with the visitor information (Screven, 1986). Moreover, learning is a sensory experience and visitors in zoos, museums, and other free-choice learning settings may be kept engrossed through engaging all their senses with color, movement, surprise, and many different things to touch, play, and interact with (Kelly, 1999). Finally, a great advantage of touch tables might be the presence of staff members or volunteers. Contrary to mere "hands-on" exhibits, these people might offer response, suggest further mental or physical activities, and, in particular, could enable cognitive links to visitors' existing knowledge and experience (Brody et al., 2002).

However, little is known about the success of touch tables as an educational tool (Koran et al., 1984; Swanagan, 2000). Results of the study of Swanagan (2000) suggest that individuals who had an active experience with the hands-on exhibits in a zoo were more likely to support conservation than visitors who had only a passive experience of viewing the animals in their exhibit and reading the accompanying graphics.

The aim of the present study was to investigate visitors' expectations and the effect of educational materials, in particular the presentation of a touch table about bearded vultures (*Gypaetus barbatus*) on visitors' learning in a Swiss zoo (Tierpark Goldau). The following specific questions were addressed: (1) Do visitors want to be informed about indigenous species? (2) Do visitors appreciate the information provided? (3) Do they feel that they learned something during their visit to the zoo? (4) Do touch tables more strongly support learning than other educational approaches? (5) Are learning gains still detectable after two months?

METHODOLOGY

The Zoo (Tierpark Goldau)

Tierpark Goldau, founded in 1925, is member of the worldwide organization of scientifically managed zoos. The zoo is situated in the boulder-strewn wilderness of Goldau in Central Switzerland and is home to mainly European species (about 250 mammals and 500 birds belonging to 75 different species). Deer, muflons, and chamois are kept in a large enclosed area that visitors can enter and where they can touch and feed the animals.

A specialty at Tierpark Goldau is its breeding station for bearded vultures (*Gypaetus barbatus*). This imposing species of vulture was a widely distributed breeding bird in Alpine regions before excessive hunting decimated the population. The last brood became extinct around 1900. As part of an ambitious re-introduction program, bearded vultures are now being bred and raised at Tierpark Goldau for subsequent release in the Alps. Visitors have free entry to the breeding station and can observe the animals in their enclosures.

Visitor Information at Tierpark Goldau

At Tierpark Goldau, visitors can make use of various types of information. Labels next to the enclosures and various posters are available all year round. During summer, zoo

professionals (so called "rangers") provide further information in the Tierpark, in particular at the various touch tables. In Goldau, touch tables have been used since 1992. They are moveable carts that contain interpretative material such as skulls, feathers, furs, or food, which visitors can touch and investigate with all their senses.

The touch table for bearded vultures contained, among other things, soil stained with iron oxide and feathers to demonstrate the bearded vulture's habit of bathing in red soil. Although some bird species have traces of iron oxide in their plumage, the bearded vulture is the only avian species known to dye its plumage from soils extensively and deliberately (Negro et al., 1999). Visitors were invited to color feathers with red soil at the touch table. Other objects presented were various animal bones and wing feathers to demonstrate the diet (bones) and size of the species (wing span of up to 3 m). The touch table was situated next to the breeding station, thus allowing visitors to investigate the interpretative material and, at the same time, to observe the living birds. For a better view of the animals, binoculars were provided. A ranger answered questions, helped visitors to observe the birds, and explained the material on the touch table.

Study Design and Treatments

Possible influences of the visitor information provided at Tierpark Goldau were evaluated using an experimental design with a test and a control group (Figure 1). During the study period, visitors had access to all the information provided, including the touch table for bearded vultures (test group) for half of each day, whereas for the other half of the day they could only gain information from labels next to the enclosures and posters (control group).

The study participants (all adults) were randomly selected. They were asked to complete a questionnaire before their visit (questionnaire 1) and another one after their visit (questionnaire 2). People, who had voluntarily given their address, were sent a third questionnaire two months later (questionnaire 3) in order to test the long-term impact of a visit to the Tierpark.

The data from the first questionnaire showed that there were no significant differences between the test group and the control group regarding age and sex, or in the answers to 21

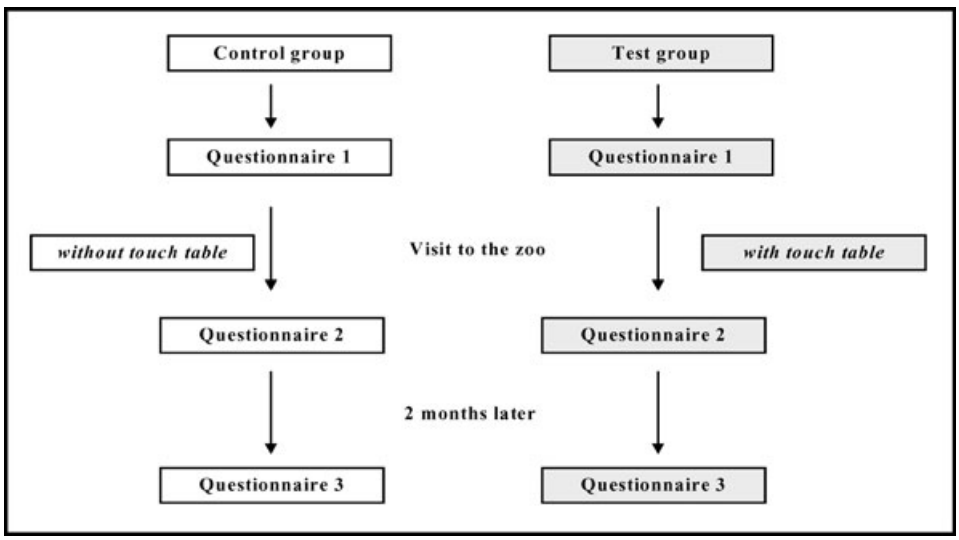

Figure 1. Experimental design.

questions regarding the motivation and frequency of their visits to the zoo and their interest in natural history (analyses of variance and chi^2-tests; $p > 0.05$).

The Instrument

The items were developed on the basis of already existing questionnaires (Berck & Klee, 1992; Hennig & Köhle, 1987; Kellert et al., 1996; Schulz, 1985; Stokking et al., 1995; Tamir, 1990–1991). A panel of experts in zoo education evaluated the content validity of the items. Based on their comments, the final items were formulated and tested in a one-day pilot study at Tierpark Goldau.

The objective of questionnaire 1 was to study the sociodemographic composition and the interests of the people visiting Tierpark Goldau. However, the results will be published elsewhere and will not be considered here.

Questionnaire 2 evaluated the visitor information provided at Tierpark Goldau. Both the test group and the control group were asked to write down which special topics they had found out about during their visit to the zoo and how they had done this. They were further asked how important for them information about indigenous species was, and how they valued the information provided. Responses to both items were obtained on a 7-point scale, ranging from totally unimportant to very important, and from very bad to very good, respectively.

The study participants were also asked to indicate whether they felt they had learned something at Tierpark Goldau. They were able to choose from five preconstructed answers. For each half-day, the proportion of users and nonusers of touch tables that had answered "yes" to a certain category of a multiple-choice question was calculated. These proportions were then used as metric variables in the statistical analyses. Finally, they were asked to answer three multiple-choice questions about the biology, ecology, and conservation of bearded vultures. For each half-day, the proportion of users and nonusers of touch tables that had given the correct answer to a question was calculated. These proportions were then used as metric variables in the statistical analyses. Both groups had had the opportunity to learn the answers to the questions during their visit to Tierpark Goldau, either by reading the labels at the breeding station (both groups) or by using the touch table for bearded vultures (test group).

Questionnaire 3 evaluated the long-term impact of a visit to the Tierpark (see Figure 1). Study participants were asked whether—and, if so, how often—they had visited Tierpark Goldau in the meantime. They were also asked whether they had sought information about an animal or animal-related topic after their visit to the Tierpark, and, if so, which information tools they had used. The other questions were similar to those asked in questionnaire 2.

The labels and posters contained all the information necessary to answer the questions in questionnaires 2 and 3: Bearded vultures are the largest indigenous birds of prey, live in high mountain areas, and feed on bones. Mature birds extensively dye their plumage from soils containing iron oxide. The birds were exterminated in the Alps at the end of the 19th century and are now being reintroduced.

Data Collection and Analysis

The data were collected in a randomized-blocks design consisting of 10 blocks (Figure 2). Each block included two days, and each day included the two treatments (test and control), one treatment in the morning and the other one in the afternoon. On the first day of each block, the two treatments were randomly allocated. On the second day, the two treatments were deliberately applied the other way round, to guarantee an equal distribution of both treatments over the whole study period.

Date	9.7.	12.7.	13.7.	14.7.	15.7	16.7.	17.7.	21.7.	22.7.	29.7.
Block	1		2		3		4		5	
Day	1	2	3	4	5	6	7	8	9	10
Morning	T	K	K	T	T	K	T	K	T	K
Afternoon	K	T	T	K	K	T	K	T	K	T

Date	30.7.	31.7.	4.8.	5.8.	7.8.	8.8.	10.8.	12.8.	14.8.	15.8.
Block	6		7		8		9		10	
Day	11	12	13	14	15	16	17	18	19	20
Morning	T	K	K	T	K	T	K	T	K	T
Afternoon	K	T	T	K	T	K	T	K	T	K

Figure 2. Distribution of the two treatments "test" and "control" over the study period (randomized-blocks design). Visitors in the control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures.

The data were collected in summer 1997 over a period of 6 weeks. On each half-day, from 19 to 22 people were questioned. A total of 639 people answered questionnaire 2 (control group: 326 people, test group: 313 people), and a total of 206 people answered questionnaire 3 (control group: 93 people, test group: 113 people).

The data were analyzed by nested analyses of variance with block and treatment as factors (randomized-blocks design). In addition, within the test group, users and nonusers of the touch table were compared. Because of the hierarchical design of the study (treatment within blocks, and use of the touch table nested within the test group), type I sums of squares were used (Scheiner & Gurevitch, 1993). All analyses were carried out with the program SPSS for Windows (SPSS Inc., 1998).

RESULTS

Use of Visitor Information at Tierpark Goldau

Both the test and control groups frequently made use of the information available at Tierpark Goldau (Table 1). They used the labels next to the enclosures as well as the posters, and 47% of the participants in the test group visited the touch table for bearded vultures.

The study participants were invited to list the topics, which they had found out about during their visit to Tierpark Goldau. Both groups wrote down a variety of topics, but

TABLE 1
Reported Use of Educational Means at Tierpark Goldau

Educational Means	Control Group (%) ($n = 326$)	Test Group (%) ($n = 313$)
No use	6.0	4.5
Labels only	20.4	14.0
Labels and posters	73.6	34.1
Labels, posters, and touch table	–	35.1
Touch table only	–	12.3
Total	100.0	100.0

Visitors in the control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures.

TABLE 2
Topics About Which Visitors Informed Themselves During Their Visit at Tierpark Goldau

Topics	Control Group (%) ($n = 326$)	Test Group (%) ($n = 313$)
Bearded vultures	13.2	47.0
Ungulates (poster)	10.1	6.1
Squirrels (poster)	12.2	5.4
Tree growth (poster)	7.1	3.2
Distribution and habitat requirements of species	4.9	3.8
Other answers	17.5	10.9
No answer	47.9	35.1

Visitors in the control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. Multiple answers were allowed.

participants in the test group informed themselves in particular about topics related to bearded vultures (Table 2).

Importance of Visitor Information at Tierpark Goldau

Both the test and control groups found information about indigenous species to be important (mean ratings: $M_{\text{test}} = 5.99$ and $M_{\text{control}} = 5.81$, respectively, on the 7-point scale). However, study participants in the test group, and, in particular, users of the touch table for bearded vultures, judged it as more important than the other participants did (Table 3).

Satisfaction with Visitor Information at Tierpark Goldau

Both the test and control groups liked the visitor information (mean ratings: $M_{\text{test}} = 6.06$ and $M_{\text{control}} = 5.86$, respectively, on the 7-point scale). However, study participants in the test group were significantly more pleased with the educational means provided than those in the control group were (Table 4).

TABLE 3
Nested Analysis of Variance of the Effects of Block, Treatment (Availability of Touch Table), and Time of Day (Morning or Afternoon) on Visitors' Assessment of the Importance of Information on Indigenous Species

Source	*df*	MS	*F*
Block	9	0.09	1.52
Treatment	1	0.43	7.25*
Residual among half-days	29	0.06	0.59
Use of touch table	1	2.13	20.93***
Residual	19	0.10	

The control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures.

Within the test group, users and nonusers of the touch table were compared.

Study participants were asked to make an assessment on a 7-point scale ranging from 1 (totally unimportant) to 7 (very important).

Levels of significance: * $p < 0.05$, *** $p < 0.001$.

TABLE 4
Satisfaction with Visitor Information at Tierpark Goldau. Nested Analysis of Variance of the Effects of Block, Treatment (Availability of Touch Table), and Time of Day (Morning or Afternoon) on the Degree of Satisfaction of Visitors

Source	*df*	MS	*F*
Block	9	0.06	0.67
Treatment	1	0.54	5.63*
Residual among half-days	29	0.09	1.22
Use of touch table	1	0.19	2.37
Residual	19	0.08	

The control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures.

Within the test group users and non-users of the touch table were compared.

Study participants were asked to make an assessment on a 7-point scale ranging from 1 (very bad) to 7 (very good).

Levels of significance: $^{*}p < 0.05$.

Self-reported Learning After Visiting the Zoo

Most study participants reported that they had learned something during their visit to Tierpark Goldau (Figure 3). However, people in the test group stated that they had learned something, in particular something about the biology of an animal, more frequently than those in the control group did (Table 5).

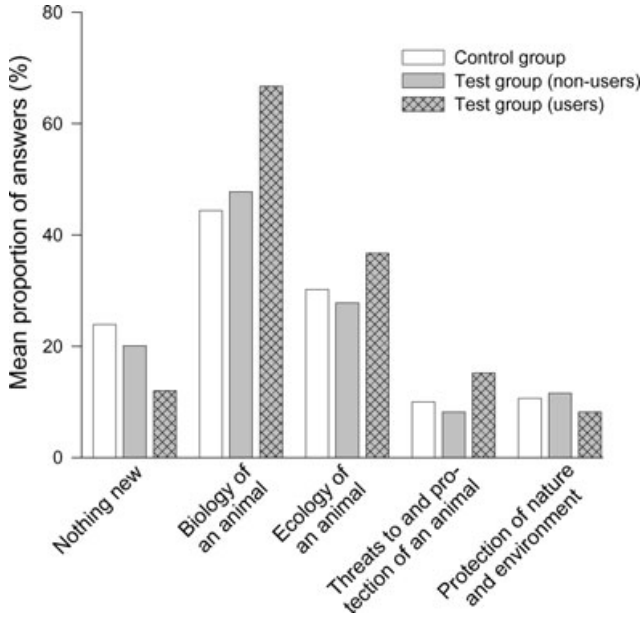

Figure 3. Answers of visitors to the question: "About what did you learn something at Tierpark Goldau?" Visitors in the control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. Within the test group, users and nonusers of the touch table were compared.

TABLE 5
Self-reported Learning at Tierpark Goldau. Nested Analyses of Variance of the Effects of Block, Treatment (Availability of Touch Table), and Time of Day (Morning or Afternoon) on Self-reported Learning by the Test and Control Group at the End of Their Visit to the Zoo

		(a) Nothing New		(b) Biology of Animal		(c) Ecology of Animal		(d) Endangered and Protected Animal		(e) Nature Conservation and Environmental Protection	
Source	*df*	MS	*F*	MS	*F*	MS	*F*	MS	*F*	MS	*F*
Block	9	217.02	1.38	507.81	1.58	351.67	1.88	195.56	3.92**	92.07	1.15
Treatment	1	829.21	5.29*	2217.17	6.91*	56.21	0.30	37.81	0.76	8.55	0.11
Residual among half-days	29	156.75	0.65	320.90	0.75	187.37	0.40	49.85	0.40	79.87	0.68
Use of touch table	1	651.32	2.68	3613.10	8.49**	802.85	1.71	493.12	3.95	117.16	0.10
Residual	19	243.19		425.45		469.05		124.79		118.32	

Within the test group, users and nonusers of the touch table were compared.

The control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. Both groups were asked whether they had learned (a) nothing new, (b) something about the biology of an animal, (c) something about the ecology of an animal, (d) something about an endangered and protected animal, and (e) something about nature conservation and environmental protection. For each half-day, the proportion of users and nonusers of touch tables that had answered "yes" to a certain category of a multiple-choice question was calculated. These proportions were then used as metric variables in the ANOVAs.

Levels of significance: * $p < 0.05$, ** $p < 0.01$.

Visitors who had used the touch table for bearded vultures as an information tool (47% of the test group) reported that they had learned something about the biology of an animal more frequently than those who had not used it (see Table 5).

Learning About Bearded Vultures

Two out of three questions about the biology, ecology, and conservation of bearded vultures were answered correctly by the test group more frequently than by the control group (Table 6). About 40% of the visitors in the test group knew the common diet of the bearded vulture and the reason for its reddish plumage, whereas only 25% and 5%, respectively, of visitors in the control group knew the right answers (Figure 4).

Moreover, visitors in the test group who had used the touch table answered all question related to bearded vultures correctly more frequently than those who had not used it (see Table 6).

Long-term Impact of a Visit to the Zoo

Two months after visiting Goldau, 17% of the study participants had sought further information about one or more of the animals seen at the Tierpark. Most of them had used books as their source of information. There was no difference between people who had visited the touch table for bearded vultures and those who had not been able to visit it (control group) or had had no interest in doing so.

Most of the study participants, and in particular users of the touch table, still had the feeling that they had learned something during their visit to Tierpark Goldau (Table 7,

TABLE 6
Learning About Bearded Vultures at Tierpark Goldau. Nested Analyses of Variance of the Effects of Block, Treatment (Availability of Touch Table), and Time of Day (Morning or Afternoon) on Learning About Bearded Vultures by the Test and Control Group

		(a) Main Diet		(b) Red Color		(c) Extinction and Re-introduction	
Source	*df*	MS	*F*	MS	*F*	MS	*F*
Block	9	206.68	0.65	201.08	0.59	149.60	1.50
Treatment	1	2809.36	8.81**	15271.28	44.60***	162.96	1.63
Residual among half-days	29	318.80	1.63	342.39	0.80	99.78	0.46
Use of touch table	1	5898.20	30.08***	12509.78	29.314***	2146.49	9.83**
Residual	19	196.07		426.76		218.46	

Within the test group, users and nonusers of the touch table were compared.

The control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. In three multiple-choice questions, both groups were asked about (a) the main diet of bearded vultures, (b) reasons for the red color of bearded vultures, and (c) the extinction and re-introduction of bearded vultures in the Alps. For each half-day, the proportion of users and nonusers of touch tables that had given the correct answer to a question was calculated. These proportions were then used as metric variables in the ANOVAs.

Levels of significance: ** $p < 0.01$, *** $p < 0.001$.

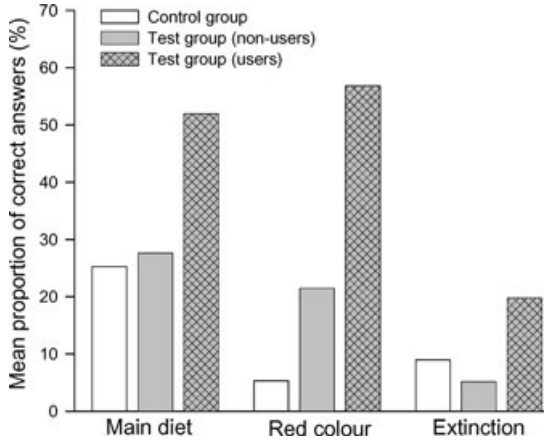

Figure 4. Proportion of correct answers to questions about bearded vultures (see Table 6). Visitors in the control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. Within the test group, users and nonusers of the touch table were compared.

Figure 5). Visitors in the test group no longer reported that they had learned something about the biology of an animal more frequently than visitors in the control group did, but, in retrospect, now felt that they had learned something about an endangered and protected animal more frequently than visitors in the control group did (see Table 7, compare Table 5).

The test group still answered two out of three questions related to bearded vultures correctly more frequently than the control group did (Table 8, compare Table 6, Figure 6).

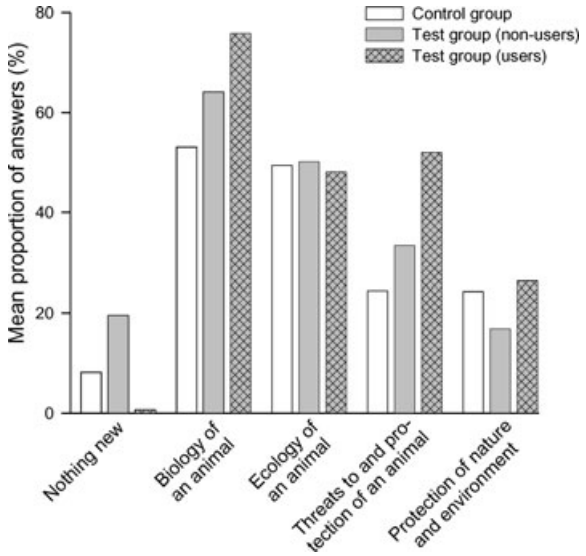

Figure 5. Answers of visitors to the question: "About what did you learn something at Tierpark Goldau?" two months after visiting Tierpark Goldau. Visitors in the control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. Within the test group, users and nonusers of the touch table were compared.

TABLE 7
Self-reported Learning Two Months After Visiting Tierpark Goldau. Nested Analyses of Variance of the Effects of Block, Treatment (Availability of Touch Table), and Time of Day (Morning or Afternoon) on Self-reported Learning by the Test and Control Group

		(a) Nothing New		(b) Biology of Animal		(c) Ecology of Animal		(d) Endangered and Protected Animal		(e) Nature Conservation and Environmental Protection	
Source	*df*	MS	*F*	MS	*F*	MS	*F*	MS	*F*	MS	*F*
Block	9	315.56	0.98	723.52	0.53	628.86	0.83	1081.12	1.43	714.70	0.95
Treatment	1	26.75	0.08	4624.90	3.41	1.81	<0.01	4410.66	5.84*	100.09	0.13
Residual among half-days	29	320.71	1.04	1354.70	1.20	760.18	0.48	755.22	0.46	754.71	0.10
Use of touch table	1	2617.08	8.45**	834.57	0.74	218.11	0.14	2569.93	1.56	473.47	0.63
Residual	17	309.76		1128.69		1576.50		1646.72		758.05	

Within the test group, users and nonusers of the touch table were compared.

The control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. Both groups were asked whether they had learned (a) nothing new, (b) something about the biology of an animal, (c) something about the ecology of an animal, (d) something about an endangered and protected animal, and (e) something about nature conservation and environmental protection. For each half-day, the proportion of users and nonusers of touch tables that had answered "yes" to a certain category of a multiple-choice question was calculated. These proportions were then used as metric variables in the ANOVAs.

Levels of significance: * $p < 0.05$, ** $p < 0.01$.

TABLE 8
Long-term Learning Effects of a Visit to Tierpark Goldau. Nested Analyses of Variance of the Effects of Block, Treatment (Availability of Touch Table), and Time of Day (Morning or Afternoon) on Knowledge About Bearded Vultures by the Test and Control Group Two Month After Visiting Tierpark Goldau

		(a) Main Diet		(b) Red Color		(c) Extinction and Re-introduction	
Source	*df*	MS	*F*	MS	*F*	MS	*F*
Block	9	936.80	0.84	946.48	1.21	1202.71	1.25
Treatment	1	2930.45	2.64	16257.99	20.82***	4030.54	4.18*
Residual among half-days	29	1111.26	1.34	780.74	0.50	963.11	1.08
Use of touch table	1	1077.42	1.30	5842.34	3.75	6296.72	7.06*
Residual	17	830.42		1556.53		892.58	

Within the test group, users and nonusers of the touch table were compared.

The control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. In three multiple-choice questions, both groups were asked about (a) the main diet of bearded vultures, (b) reasons for the red color of bearded vultures, and (c) the extinction and re-introduction of bearded vultures in the Alps. For each half-day, the proportion of users and nonusers of touch tables that had given the correct answer to a question was calculated. These proportions were then used as metric variables in the ANOVAs.

Levels of significance: * $p < 0.05$, *** $p < 0.001$.

To avoid bias (accumulative effect of learning), the data were also analyzed solely with study participants who, in the meantime, had neither visited the Tierpark nor sought information about one or more of the animals seen there. The test group was still able to answer the two questions related to bearded vultures correctly more frequently than the control group did.

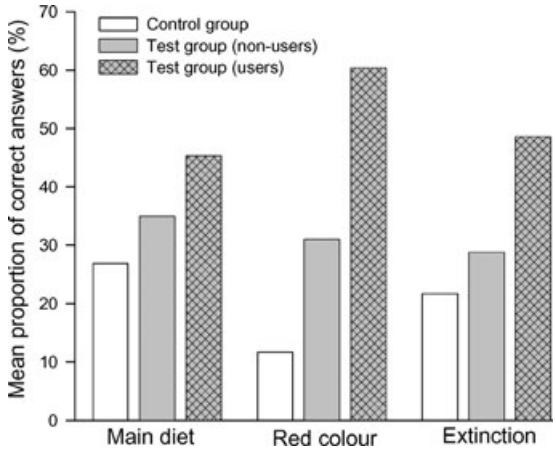

Figure 6. Proportion of correct answers to questions about bearded vultures two months after visiting Tierpark Goldau (see Table 8). Visitors in the control group could only gain information from labels next to the enclosures and from posters, whereas the test group could in addition use the touch table for bearded vultures. Within the test group, users and nonusers of the touch table were compared.

DISCUSSION

Zoos, like other recreational facilities, are social settings that are often visited by families or friends who want to enjoy their leisure time together and watch their favorite animals (Falk, Koran, & Dierking, 1986). People's particular choice of zoos over other leisure-time destinations indicates an interest in seeing the living animals that zoos exhibit and in learning about these creatures (IUDZG/CBSG (IUCN/SSC), 1993). Zoo visitors themselves regard learning as an important part of their visit (Birney, 1988; Hennig & Köhle, 1987; Holzer, Scott, & Bixler, 1997; Kamer, 1998; Serell, 1977). The present study revealed that visitors at Tierpark Goldau wanted to be informed about indigenous species and used the educational material offered to them. The test group, who was able to seek information from a variety of sources, used both the "modern" touch table for bearded vultures and the more "traditional" labels next to the enclosures as well as the posters. This is a pleasing result because for most of the year only the written information is available at the zoo.

However, the control group, who was only able to seek information from the labels and posters, reported that they had learned something new less frequently than the test group did. Although people do look at labels or diagrams in zoos, museums, and other settings of informal education (Milan & Wourms, 1993; Schoch, 1997), the information given is often too dry and unappealing to hold their interest for a long time, and thus too briefly looked at to result in meaningful learning gains (Korenic & Young, 1991; Marsland, 1995; Moscardo, 1988; Tunnicliffe, 1995; Zaremba & Toedter, 1995). Zoo visitors normally do not want to read a book (Falk et al., 1986), but want to be informed in a pleasant and entertaining way during their leisure time (Birney, 1988; Falk et al., 1986; Moscardo, 1988; see also Falk et al., 1998). Interactive experiences like those offered by touch tables are seen as successful tools in a zoo's efforts to meet the visitors' expectations (Swanagan, 2000). This is supported by the fact that in the present study visitors who had access to the touch table were more satisfied with the visitor information than those who had not.

At Tierpark Goldau, the interactive educational approach was successful. The test group, in particular the users of the touch table for bearded vultures, reported that they had learned something about the biology, ecology, and conservation of animals more frequently than the control group did. Visitors' self-evaluation matched their actual learning gains. A higher proportion of visitors in the test group, in particular those who had actually used the touch table, gave correct answers to questions about bearded vultures, both immediately after their visit to the zoo and two months later. Although only half of the test group had visited the touch table, topics related to bearded vultures were among the most commonly listed topics about which they had sought information during their visit. The mere existence of the touch table seemed to have drawn the visitors' attention toward the animal concerned.

There are several, not mutually exclusive explanations for the success of the touch table for bearded vultures. First of all, the touch table included entertaining hands-on activities, such as the opportunity for visitors to dye feathers with soil stained with iron oxide. The integration of interactive, entertaining elements has been found to have a positive effect on the attractiveness of the educational means offered in museums and zoos (Koran et al., 1984; Peart, 1984; Moscardo, 1988; Miller & Gore, 1996; Woolard & Smart, 1996). Nonmanipulative objects such as labels or posters provide only minimal opportunities for visitors to satisfy their curiosity with more than one perceptual channel, whereas, in contrast, objects presented for inspection permitting touch, hearing, sight, and, perhaps taste and smell, attract and hold visitor attention for longer periods of time and increase visitors' curiosity and interest (Koran et al., 1984; but see Sandifer, 2003).

However, visitor enjoyment and visitor learning are not necessarily related. A combination of interpretative material and visual experience of living animals (in our study the

opportunity to watch bearded vultures in their nearby enclosures) was found to be highly effective in fostering long-lasting learning experiences (Wineman et al., 1996; see also Tunnicliffe et al., 1997). This might also explain why, after their visit to the zoo, the test group in particular remembered topics related to bearded vultures, although they had sought information about a variety of other issues.

The touch table for bearded vultures provided information about a rare species that visitors might otherwise not know about or seldom see in the wild. This might also explain its success, because the presentation of novelties in exhibitions has been found to increase visitors' attention and interest (Screven, 1986), and increased interest was found to result in mindfulness, a basic component of successful learning (Moscardo, 1988). However, the strongest success factor of the touch table for bearded vultures might be the opportunity it offers for "dialogue" between zoo professionals as interpreters and visitors as active respondents. In contrast to mere written information, oral information at touch tables can be built up on visitors' prior knowledge and experiences, an important prerequisite for learning (Brody et al., 2002). Even children on organized school visits, who are in comparison to zoo visitors a much more homogeneous group, were found to learn more when instructed by zoo or museum professionals than when they had to seek information themselves with the help of labels or diagrams (Stronck, 1983; Birney, 1988).

Thus, the impact of the touch table for bearded vultures at Tierpark Goldau may actually be a combination of hands-on learning and informal facilitation by zoo rangers. The present study does not allow to differentiate between the relative contribution of these different aspects of the touch table experience. Future studies should therefore tease apart these factors and should include a treatment group where the touch table is available, but unmanned in addition to a fully manned touch table.

As shown in the present study, touch tables are successful in explaining more complex issues, like the ecology and conservation of animals. However, visitors at zoos or other settings for nature education are a diverse group, and multiple levels of educational material are thus required to meet their needs (Wineman et al., 1996). People visiting zoos are open to receiving information about animals, which means they are susceptible to education in their leisure time. Improving education increases the zoo's attractiveness, which also might go hand in hand with increased visitor attendance (IUDZG/CBSG (IUCN/SSC), 1993).

However, for an improvement of informal education, it is not only important to investigate to *what extent*, but also for *which visitors* free-choice learning settings do accomplish their educational mission (Falk & Adelman, 2003), and *how* the learning experience contributes to what a visitor knows, feels, or understands (Falk & Dierking, 2002). Learning is both a process and a product, so the processes of learning as well as the products should be investigated (Rennie et al., 2003). Future studies on visitors' learning in a zoo should therefore also investigate visitors' motivations for visiting the setting and the strategies they utilize during the visit (Falk et al., 1998). Visitors' past experience with an object on display, his or her familiarity with the location, and their discussions with a companion should all be considered (Cox-Petersen et al., 2003; see also recommendations in Brody et al., 2002; Anderson, Lucas, & Ginns, 2003; Rennie & Johnston, 2004).

Moreover, future research should investigate the cognitive anchors and bridges visitors use to construct knowledge connections (Brody et al., 2002). If these anchors and bridges are known, new presentation approaches such as staff or volunteer-facilitated touch tables that address the public understanding of important ecological concepts and conservation issues could be developed or improved accordingly.

The "average" visitor spends only a small amount of time in a zoo or at exhibits (see overview in Moscardo, 1988). It has thus been suggested that zoos have only a limited

potential to influence visitors' behavior in terms of nature conservation (Bitgood, 1989). However, the educational potential of zoos has probably been underestimated. Many people visit zoos more than once a year (Kamer, 1998), and, as reported in the present study, use books to gain further information about animals or animal-related topics after their visit. This is probably one of the most valuable effects of a visit to a zoo, because repetitive learning results in deeper learning gains and understanding (Ausubel, 1968; Falk & Dierking, 1997; Rennie & Johnston, 2004).

In conclusion, presenting touch tables is costly but effective. Touch tables are a successful tool with which to offer information about the biology, ecology, and conservation of animals to a broad audience and with which to promote conservation. They might help zoos to fulfill one of their avowed aims, to inform visitors about the importance of nature conservation. The use of touch tables results in long-term learning effects if the story that is told at the touch tables is interesting and new. It is therefore recommended that more use be made of touch tables in zoos, museums, visitor centers, and other settings for nature education.

APPENDIX

Previsit Questionnaire

1. How old are you?
2. Are you female/male?
3. What is the zip-code of your place of residence?
4. How important are the following reasons for your visit to the zoo today? *(Cross **one** statement each)*

    - Recreation *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
    - Having fun *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
    - Seeing young animals *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
    - Seeing local animals *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
    - Learning something about animals *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
    - Feeding animals *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
    - Learning how I could do something for nature conservation *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
    - Visiting Tierpark Goldau with children *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*

5. How often do you visit Tierpark Goldau? *(today is the first time; seldom; about once a year; 2–5 times a year; more than 5 times a year)*
6. Do you also visit other zoos? *(never; seldom; about once a year; 2–5 times a year; more than 5 times a year)*
7. Do you visit nature museums or exhibits about nature? *(never; seldom; about once a year; 2–5 times a year; more than 5 times a year)*
8. Do you visit national parks or other protected areas? *(never; seldom; about once a year; 2–5 times a year; more than 5 times a year)*

9. How important is it for you to know local plants? *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
10. How important is it for you to know local animals? *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
11. How often do you observe animals in nature? *(never; less than once a month; 1–3 times a month; once a week; more than once a week; nearly daily)*
12. How often do you read books or journals about nature? *(never; less than once a month; 1–3 times a month; once a week; more than once a week; nearly daily)*
13. How often do you watch videos or films about nature? *(never; less than once a month; 1–3 times a month; once a week; more than once a week; nearly daily)*
14. Cross the most important factor that threatens animal species of Switzerland *(hunting; habitat loss; toxic substances; loss of ozone layer; predators; traffic)*
15. How much do you know about local animal species? *(very little; little; fairly little; neither nor; fairly much; much; very much)*
16. How much do you know about nature conservation? *(very little; little; fairly little; neither nor; fairly much; much; very much)*
17. How important is nature conservation for you? *(completely unimportant; unimportant; fairly unimportant; neither nor; fairly important; important; very important)*
18. Are you engaged in nature conservation? (***Several*** *answers possible) (I am not specifically engaged in nature conservation; I am a member of a nature conservation organization; I help with nature conservation activities such as planting hedges, constructing ponds; I am engaged in nature conservation activities in my direct surroundings such as my garden, balcony, neighborhood; else . . .)*

Thank you for answering the questions, until later!

Postvisit Questionnaire

1. Write down the one animal species you liked best at Tierpark Goldau *(only* ***one*** *answer)*
2. Which of the following educational means have you used at Tierpark Goldau? *(Labels; Touch table for bearded vultures; Posters; None)*
3. About which topics have you sought information during your visit at Tierpark Goldau?
4. How important is it for you to be informed about local animals at Tierpark Goldau? *(Completely unimportant; Unimportant; Fairly unimportant; Neither nor; Fairly important; Important; Very important)*
5. How did you like the visitor information at Tierpark Goldau? *(Very little; Little; Fairly little; Neither nor; Fairly much; Much; Very much)*
6. About which of the following topics would you like to be informed at Tierpark Goldau? *(Birth of animals; Extension plans; Biology of animals; Endangered and protected animals; Nature conservation; Else: ...)*
7. What have you learnt during your visit at Tierpark Goldau? (***Several*** *answers possible) (Nothing new; Something about the biology of an animal; Something about the ecology of an animal; Something about an endangered and protected animal; Something about nature conservation and environmental protection)*

Some question about bearded vultures:

8. What is the main diet of bearded vultures? (***One*** *answer) (Hares; Ungulates such as deer, chamois; Plants; Carrion; Bones)*

9. What is the reason for the red color of grown up bearded vultures? (***One*** *answer) (Uptake of colored diet; Bathing in colored mud; Endogenous color pigments; Rusty feathers)*
10. Which of the following statements are true: (***Several*** *answers possible) (In the beginning of this century bearded vultures became extinct in the Alps; Bearded vultures have never become extinct in Switzerland; All bearded vultures that are currently living in the Alps are re-introduced; Bearded vultures have gone extinct because their diet was contaminated with toxic substances; Power lines have already caused victims among bearded vultures)*

Questionnaire Two months After the Visit

1. Have you visited Tierpark Goldau again after the survey? *(Yes; No)*
2. Have you sought out more information about specific animal species seen at your visit at Tierpark Goldau? *(No; if yes, which information? Write down how you have gathered this information)*
3. Write down the one animal species you liked best at Tierpark Goldau.
4. Write down the topics about which you have sought information during your visit at Tierpark Goldau.
5. Can you still remember what have you learnt during your visit at Tierpark Goldau? (***Several*** *answers are possible) (Nothing new; Something about the biology of an animal; Something about the ecology of an animal; Something about an endangered and protected animal; Something about nature conservation and environmental protection)*

Again some questions about bearded vultures:

6. What is the main diet of bearded vultures? (***One*** *answer) (Hares; Ungulates such as deer, chamois; Plants; Carrion; Bones)*
7. What is the reason for the red color of grown up bearded vultures? (***One*** *answer) (Uptake of colored diet; Bathing in colored mud; Endogenous color pigments; Rusty feathers)*
8. Which of the following statements are true (***Several*** *answers are possible) (In the beginning of this century bearded vultures became extinct in the Alps; Bearded vultures have never become extinct in Switzerland; All bearded vultures that are currently living in the Alps are re-introduced; Bearded vultures have gone extinct because their diet was contaminated with toxic substances; Power lines have already caused victims among bearded vultures)*

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