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Research article

The impact of exhibit design on zoo visitor dwell time based on an unobtrusive observational methodology in Central European zoos

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Abstract

In this study, the effect of different exhibit designs on visitor dwell time was evaluated based on an unobtrusive and covert observation method in Budapest Zoo, Prague Zoo and Sosto Zoo. The time spent showing direct interest toward the species in an exhibit was measured. Observations took place under the criteria of visibility and fixed weather conditions. Exhibits displaying members of Cervidae and Bovidae were investigated to minimise taxonomic and size differences. The results demonstrate a clear difference between the times spent at different exhibits in the zoos. There was no influence of taxonomic group on visitor dwell time. However, the study showed exhibit features that did affect visitor dwell time. Overall, four features appeared to increase dwell time, one decreased dwell time, and seven had no significant influence. This study provides a generalised estimate that can be applied in different geolocations and aimed at visitors with different demographic characteristics. The results will allow zoos to strategically plan the design of their exhibits and use these features to increase visitor interest, although further research is needed to translate this engagement into pro-conservation knowledge and action.

Introduction

Previously zoos and aquariums focused on showing a wide variety of exotic animals only for the entertainment of the public. However, zoo exhibits have undergone significant development during the past few decades (Davey 2006; Hediger 1970; Mullan and Marvin 1987). They have been transformed from using classic menagerie-type cages to modern naturalistic exhibits that aim to improve both animal welfare standards and education (Hancocks 1980; Shepherdson et al. 1998). Today, zoological facilities provide an unrivalled platform for visitors to awaken their desire to care for life on earth, positively influencing their pro-environmental behaviour, e.g. through donation (Barongi et al. 2015). In the age of urbanisation, zoos bring nature closer to the public by creating tiny green islands in the world of buildings, vehicles and roads. As visitors enter the zoo, they become part of a free-choice learning environment (Briseño-Garzón et al. 2007; Falk 2005; Falk and Adelman 2003; Storksdieck et al. 2005). They orient themselves according to their previous disparate knowledge, follow their own interest and choose between exhibits based on their attractiveness (Davey 2006). In this system the learning potential, although difficult to quantify, could be strongly related to the attractiveness of the species and the interest of visitors towards them. Learning can be facilitated through subjects in which the learner has a personal interest (Rennie and Johnston 2004) or with which they have an emotional affinity (Ballantyne and Packer 2005). The field of visitor studies, which examines effects on visitor dwell time, has emerged relatively recently and is diverse and interdisciplinary (Davey 2006). Previous results show what visitors like (visible, active, colourful) and dislike (slimy, smelly, animals that bite or sting) (Whitworth 2012). In addition, in former studies, the structural aspects of exhibit design (Johnston 1998) and taxonomic categorisation (Moss and Esson 2010) appear to be the most important factors influencing visitor dwell time.

Visitor studies (Bitgood 1989, 2002; Loomis 1988) in zoo conditions can help aid planners to develop and evaluate appealing exhibits and understand and promote utilisation of exhibit areas. Appealing exhibits help to attract a broad representation of visitor audiences, provide higher educational potential and offer a more fulfilling experience. In addition, they enable an investigation of the visitor market to aid the development of business and marketing strategies (Ament 1994; Bitgood and Shettel 1996; Maitland 2000). It is important to understand the potential of visitor studies as previous results showed that the primary motivation for zoo visits is to see new exhibits (Roe and McConney 2015). Contrary to the importance of such research there was no zoo-specific visitor study until the 1970s (Hediger 1970). Today there are still limitations in the existing literature, including independence between research fields, a lack of international studies, limited generalisability of results and the poor status of the field (Bitgood et al. 1988; Davey and Henzi 2004; Davey et al. 2005; Johnston 1998).

This study addresses three questions:
1) Are there significant differences between the three zoo areas in this study in terms of mean visitor dwell time of the investigated exhibits?
2) Do different groups of ungulate species have a significant influence on visitor dwell time?
3) Which characteristics of the exhibits have significant positive or negative effects on visitor dwell time?

Materials and methods

This study was developed using an observational method, with the aim of evaluating the effect of exhibit design on visitor dwell time. Unobtrusive and covert recording of visitor dwell time took place, and the characteristics of the visited exhibits were assessed. Certain criteria were defined during data collection to exclude the maximum number of possible external variables. To minimise the influence of taxonomy (Moss and Esson 2010), only exhibits displaying members of Cervidae and Bovidae were studied. These mammalian taxonomic families are represented by numerous species in zoos and are available in diverse exhibit designs. The study took place at three research sites to address the gap of generalisability of results among different zoos. After investigating the existence of potential taxonomic influence on visitor dwell time, this study researched the exhibit design features that influence visitor dwell time. Animal characteristics were not investigated in this study.

Anonymous data on visitors was collected and pooled. The only variable measured was the dwell time. No personal information (e.g. sex or age class) was recorded and visitors at the exhibits were randomly monitored. No video or audio was recorded. Data collection had no greater impact on subjects than the presence of any other visitor. No information was given about the observations at the zoo entrance, since potential unpleasant feelings could have manifested in some visitors (more than 99% of them not included in the study), meanwhile direct information given to the subjects at the exhibits in question could have also affected behaviour. On the other hand, none of the visitors noticed the data collection and none asked to withdraw from the study. But in case of such a request, their data would have been excluded. The methods followed guidelines set by the General Data Protection Regulation (EU) 2016/679 (GDPR).

Research sites

Budapest Zoo

This zoo is a traditional urban zoological and botanical garden in the centre of Budapest, Hungary. It possesses several restored, historic listed buildings and many well-known tourist attractions surround the area. Annual visitor numbers reach 1.1 million (Sheridan 2016). The area of the zoo chosen was primarily flat and, due to its small size (10.8 ha), it was uncomplicated to get from one exhibit to another. From the 124 displayed mammal species, eight members of Bovidae and Cervidae placed in six exhibits were chosen (Table 1). Species in the Holnemvolt Park area were not included since tickets were sold with exclusive entrance for that area, so it could not have been considered that everyone there was a 'whole-day' zoo visitor.

Prague Zoo

Prague Zoo is situated high above the Vltava in the Czech Republic on an attractive rocky slope and has moated islands, rocky areas, tree cover and various types of vegetation. The zoo is one of the most visited European zoos with 1.4 million visitors annually (Sheridan 2016). Prague Zoo has the largest total zoo area among the examined zoos with 50 ha available for visitors. The area is quite mountainous with several slopes, which influenced the overall time taken for data collection as did the greater distance between the exhibits. The data collection was not uncomplicated at all exhibits, many of which required a change in observation point due to the concave shape of the exhibits' viewing area. Prague Zoo displayed the largest number of species from Bovidae and Cervidae—24 out of 160 exhibited mammal species—although not all could be included. Exhibits of Nile lechwe *Kobus megaceros* and lowland anoa *Bubalus depressicornis* were not included in the study due to time limits, thus 22 exhibited species in the zoo were investigated (Table 2).

Table 1. Species in different exhibits investigated during the research at Budapest Zoo

Number	Species in each exhibit
1.	Forest buffalo *Syncerus caffer*
2.	Barbary sheep *Ammotragus lervia* with hamadryas baboon *Papio hamadryas*
3.	Blackbuck *Antilope cervicapra* and takin *Budorcas taxicolor* with Visayan warty pig *Sus cebifrons*
4.	Dama gazelle Nanger dama and waterbuck *Kobus ellipsiprymnus* with black crowned-crane *Balearica pavonina*, helmeted guineafowl *Numida meleagris*, giraffe *Giraffa camelopardalis* and white stork *Ciconia ciconia*
5.	Dama gazelle *Nanger dama*
6.	Mouflon *Ovis orientalis*

Sosto Zoo

Sosto Zoo is 5 km from the city centre of Nyiregyhaza, Eastern Hungary and is set in a 700 ha natural oak forest that allows the zoo to exhibit species in both open and wooded large areas. The zoo is relatively new, having been established in 1996. Its collection of 126 mammal species is comparable to that of the other two zoos, whereas the visitor numbers reach 0.5 million each year (Sheridan 2016), which is less than at the other zoos. The area of Sosto Zoo (40 ha) is similar to that of Prague Zoo, but there were no elevation differences, which eased the data collection. Most of the exhibits were easily observable from one point. Data were collected from 16 species in the Bovidae and Cervidae families (Table 3).

Data collection

Recording visitor dwell time at exhibits

The observation method was developed based on previously defined guidelines (Mitchell and Hosey 2005). Visitor dwell time at exhibits was measured; this variable has been used in previous investigations aiming to reflect the interest of visitors towards certain species (Johnston 1998; Moss and Esson 2010; Moss and Pavitt 2019; Zwinkels et al. 2009). Records included the time spent observing the animals and their environment, reading the information signs related to the species, taking photographs of the species and interacting with the animals. The measurement started from the first signs of interest until visitors stopped paying attention to the animals and the exhibit. If they stopped observing the animal due to disturbance by other people, the recording time was stopped temporarily until they resumed observation.

To exclude taxonomic differences as much as possible, only exhibits displaying members of the Cervidae and Bovidae families were included. In addition, species of very small and very large size (such as *Giraffa, Muntiacus* and *Madoqua* genera) were excluded from the study in order to limit the potential influence of different body sizes (Bitgood et al. 1988; Moss and Esson 2010; Ward et al. 1998).

For measuring the visitor dwell time, a phone was used as a stopwatch, while data were recorded on a data collection sheet. Data were recorded from eight visitors per exhibit during each investigation day, thus eighty datapoints were collected from each exhibit after repeating data collection over ten days. For each

Table 2. Species in different exhibits investigated during the research in Prague Zoo

Number	Species in each exhibit
1.	Addax *Addax nasomaculatus*
2.	American bison *Bison bison* with Canada goose *Branta canadensis*
3.	Barbary sheep *Ammotragus lervia* with barbary macaque *Macaca sylvanus*
4.	Common beisa oryx *Oryx beisa beisa*, blesbok *Damaliscus pygargus*, common eland *Tragelaphus oryx* and southern lechwe *Kobus leche* with common ostrich *Struthio camelus* and giraffe *Giraffa camelopardalis*
5.	Bighorn sheep *Ovis canadensis*
6.	Blue sheep *Pseudois nayaur*
7.	Bongo *Tragelaphus eurycerus*
8.	Eld's deer *Rucervus eldii*
9.	European bison *Bison bonasus*
10.	Himalayan tahr *Hemitragus jemlahicus*
11.	Javan deer *Rusa timorensis* with Reeves' muntjac *Muntiacus reevesi*
12.	Moose *Alces alces*
13.	Reindeer *Rangifer tarandus*
14.	Sable antelope *Hippotragus niger*
15.	Scimitar-horned oryx *Oryx dammah*
16.	Sitatunga *Tragelaphus spekii* (1) with marabou *Leptoptilos crumeniferus*
17.	Sitatunga *Tragelaphus spekii* (2) with southern ground-hornbill *Bucorvus leadbeateri*
18.	Takin *Budorcas taxicolor*
19.	Western tur *Capra caucasica*
20.	White-lipped deer *Cervus albirostris*

Table 3. Species in different exhibits investigated during the research in Sosto Zoo.

Number	Species in each exhibit
1.	Addax *Addax nasomaculatus*
2.	American bison *Bison bison*
3.	Argali *Ovis ammon*
4.	Barbary sheep *Ammotragus lervia* with pygmy hippopotamus *Choeropsis liberiensis*
5.	Blackbuck *Antilope cervicapra* with Asian elephant *Elephas maximus*
6.	European bison *Bison bonasus*
7.	Fallow deer *Dama dama*
8.	Gemsbok *Oryx gazella* and greater kudu *Tragelaphus strepsiceros*
9.	Red deer *Cervus elaphus*
10.	Reindeer *Rangifer tarandus*
11.	Sable antelope *Hippotragus niger* and sitatunga *Tragelaphus spekii* with giraffe *Giraffa camelopardalis* and Grevy's zebra *Equus grevyi*
12.	Sika deer *Cervus nippon*
13.	Southern lechwe *Kobus leche* (1) with great white pelican *Pelecanus onocrotalus*
14.	Southern lechwe *Kobus leche* (2)
15.	Takin *Budorcas taxicolor*

Table 4. Different exhibit features analysed.

Exhibit features	
With bridge-like walkway	Without bridge-like walkway
With stopping point	Without stopping point
Several viewing angles available	One viewing angle available
Fence is higher than 1.5 m	Fence is lower than 1.5 m
With barrier(s) wider than 1 m	Without barrier wider than 1 m
Completely enclosed by barrier(s) wider than 1 m	Side available without barrier wider than 1 m
More than five cases of feeding by visitors recorded during data collection	Five or fewer cases of feeding by visitors recorded during data collection
Different species exhibited together	Single exhibited species
Placed within 75 m of one or more restaurants	Restaurants are not placed within 75 m of the exhibit
Exhibit is among the four exhibits closest to the entrance	Exhibit is not among the four exhibits closest to the entrance
Recessed terrain compared to visitor pathway	Terrain is not recessed compared to visitor pathway
Terrain includes elevated features compared to visitor pathway	Terrain does not include elevated features compared to visitor pathway

chosen exhibit data were recorded six times on week days and four times on weekends. Visitors were chosen randomly; the next available visitor arriving after the previous record had finished was selected. For visitor groups the leading group member was not necessarily chosen, as in the study by Moss and Pavitt (2019); even the last member of the group could be selected. Data collection began between 0900 and 1000. Data recorded until 1300 were categorised as morning records, while those from 1300 until 1600–1700 were categorised as afternoon records. For each exhibit throughout the ten days, half of the records were available from the morning and half from the afternoon interval. An average day took 6–7 hours, but there were slight differences between given days and given zoos arising from the available visitor density for recording and the number of exhibits, as well as the distance and difference of altitude between the exhibits.

Assessment of exhibits

The second part of data collection comprised evaluation of the features of all investigated exhibits. Exhibits were categorised according to variables that might influence visitor dwell time (Table 4) and this categorisation was used as a basis for later analyses. Assessments were made during the data collection days so that the exact outlook at the time of the study was described. Visitor areas were investigated for bridge-like structures, specially designed locations ('stopping points') and available angles from which to observe the animals to see how these characteristics influenced visitor dwell time. The way of enclosing the animals was recorded in terms of the height of fences, the presence and width of barriers, possibilities to contact the animals and number of species exhibited together. The proximity of restaurants and entrances to the exhibits was also recorded. In addition, the internal design of exhibits was investigated through the shape of the terrain (Table 4).

Statistical analysis

Data were evaluated in three steps, in line with the research questions. The first step was to make sure that—after applying all the methodological criteria—the difference still existed in the research areas between the included exhibits. The step started with summarising visitor dwell time for each individual exhibit. From the 80 recorded dwell times for each exhibit (n=3280, i.e. 80×41), means and standard deviations were calculated. Results were organised into a diminishing rank list, where the exhibit with the highest mean visitor dwell time was the first and that with the lowest value the last. Ranks were assigned in this way for each of the three zoos.

The second step consisted of comparison of four specific groups of ungulate species to reveal the effect of exhibited species on visitor dwell times. The four specific groups were categorised on a taxonomic basis (except in the case of *Tragelaphus*): antelopes, buffaloes, deer and goats (Table 5). As the data showed normal distribution after performing the Anderson-Darling test, one-way ANOVA tests (with Tukey post-hoc tests) were used. In Budapest Zoo only two species categories could be analysed due to a lack of data; thus, in this case a t-test was used.

The third step aimed to target the impact of exhibit design on visitor dwell time. For all variables defined in the exhibit evaluation (Table 4), all exhibits were recorded as either showing a given feature or not. A t-test or Mann-Whitney U-test (based on the normality of datasets established with the Anderson-Darling test) was used to reveal differences in visitor dwell time between exhibits with and without each characteristic.

Table 5. Ungulate species groups investigated.

Group names	Members from taxonomic group
Antelopes	*Tragelaphus* (from Bovinae), Antilopinae, Reducinae, Hippotraginae, and Alcelaphinae
Goats	Caprinae
Deer	Cervidae
Buffaloes	*Syncerus, Bubalus, Bos* and *Bison* (from Bovinae)

Results

Figures 1, 2, and 3 show that differences exist between the examined exhibits. The highest recorded visitor dwell time appeared at Sosto Zoo (max=945 sec), while the lowest (min=0 sec) appeared in several cases, at almost all exhibits. Budapest Zoo, with the least available exhibits (n=6), had the highest average zoo dwell time (mean=53.42 sec). Mean visitor dwell times varied widely (min=18.74 sec, max=147.3 sec) between the exhibits of Budapest Zoo (Figure 1). Prague Zoo, with the most available exhibits, had the lowest average zoo dwell time (mean=43.44 sec) and the most balanced distribution of visitor dwell time between the exhibits (min=12.88 sec, max=107 sec) (Figure 2). Sosto Zoo with an average zoo dwell time of 52.6 sec had the greatest range in visitor dwell times (min=9.46 sec, max=271.24 sec) (Figure 3).

Among 12 exhibit characteristics, four had significant effects on increasing visitor dwell time (Figure 5), listed here in decreasing order of P-value: making more sides with different viewing

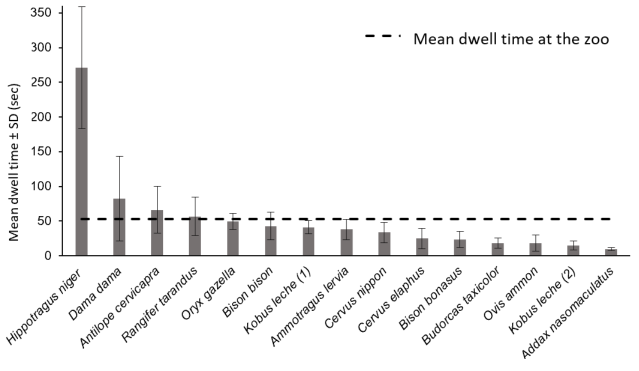

Figure 3. Visitor dwell time at Sosto Zoo.

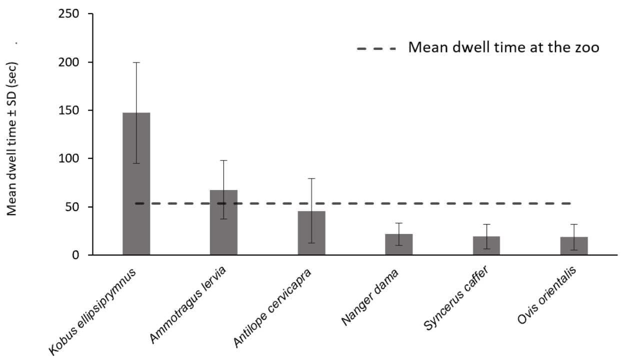

Figure 1. Visitor dwell time at Budapest Zoo.

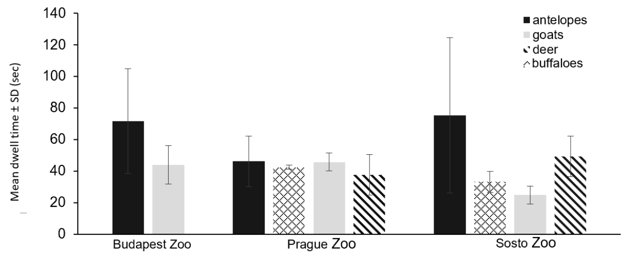

Figure 4. Differences in the dwell time at exhibits of different groups of ungulate species in the three zoos investigated.

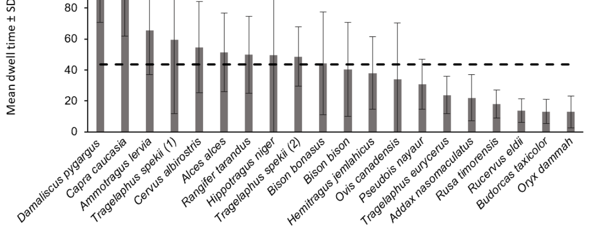

Figure 2. Visitor dwell time at Prague Zoo.

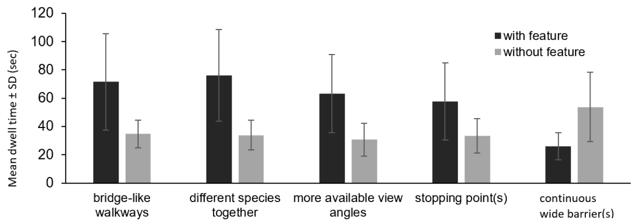

Figure 5. The most important features of exhibits that resulted in significant differences in mean dwell time between exhibits with or without the given characteristics.

angles available for visitors (Mann-Whitney U-test: n=35, U=253, P=0.001), keeping two or more species within the same exhibit (t-test: n=41, t=3.12, P=0.003), creating bridge-like walkways for observation (t-test: n=35, t=2.44, P=0.02) and building stopping points into exhibit design (Mann-Whitney U-test: n=35, U=221, P=0.02). Continuous wide barriers around the viewing area of exhibits caused significantly lower dwell times (n=35, U=169, P=0.02). Further comparisons of exhibits with and without a given feature did not show any significant influence.

Discussion

The study demonstrated a clear difference in visitor interest between the selected exhibits. As with Johnston (1998), structural aspects of the exhibit appeared to be a significant determinant of visitor dwell time. The results showed no significant preference toward any of the investigated ungulate species contrary to the study of Moss and Esson (2010) where significant taxonomic differences appeared. This confirms the independent significance of exhibit design on visitor interest. Factors such as the effect of different activity levels (Moss and Esson 2010), visitor characteristics (Johnston 1998) and visitor crowding (Zwinkels et al. 2009) still could have somewhat influenced the interest of visitors. Their influence is assumed to be distributed randomly due to cautious sampling based on day and weather criteria.

The factors that had the most influence on increasing visitor dwell time include: making more sides with different viewing angles available to visitors, keeping two or more species within the same exhibit, creating bridge-like walkways for observation and building stopping points into the design. The mean visitor dwell time at exhibits with these features was significantly higher. More available viewing angles for observation and stopping points likely allow the visitors to observe the animals up close and create better viewing possibilities. Thus, the proximity to animals led to greater appreciation and higher mean visitor dwell time at such exhibits (Clayton et al. 2008; Moss and Pavitt 2019; Mun et al. 2013; Skibins and Powell 2013). Different species in the same exhibit could have been more popular due to the excitement of observing how the animals interact, and through advancing a naturalistic image (Nakamichi 2007; Ross et al. 2012). It can be supposed that the positive effect of bridge-like walkways arose from the changed viewing angle and visitor area. The change in elevation or type of terrain allowed for observation of the animals from a novel viewpoint which could have led to higher interest.

Continuous wide barriers around the exhibit viewing area appeared as the only factor that resulted in significantly lower mean visitor dwell time. This is probably a result of preventing visitor proximity to the animals and offering poorer visibility (Clayton et al. 2008; Skibins and Powell 2013). A recent study by Moss and Pavitt (2019) also found that more immersive walk-through exhibits which offered a view without barriers increased visitor engagement with the housed animals. Zoos should promote solutions where visitors feel themselves surrounded by the animals, being a part of their habitat, rather than walking on broad pathways. Wide barriers should be minimised in future designs or used very carefully where they are a necessity.

Investigated factors like proximity to restaurants, proximity to entrances and exhibits with recorded frequent feeding may not have had positive effects due to the crowding effect (Zwinkels et al. 2009). While some visitors spent an above average amount of time at such exhibits, others avoided these places. The subordination theory based on positioning (Coe 1985) failed in the case of recessed angular view and exhibits placed on elevated slopes. In addition, the presence of barriers seemed to be more important than the height of the fence. Overall, the study showed the immersive-style exhibits, without any obvious barriers and a naturalistic impression, can have an attractive effect on visitor behaviour, as in previous studies (Ross and Gillespie 2009; Yılmaz et al. 2017).

Conclusion

By knowing the specific features that can significantly enhance the interest rate of visitors in exhibits, zoos can make improvements in exhibit design. Zoos can consider incorporating these features into future designs or renovating existing exhibits to include appreciated features. If zoos improve exhibit design, they might increase the environmental education potential for visitors. Improvements can also be used to highlight certain species that are in urgent need of conservation actions. In addition, by increasing visitor dwell time zoos have the potential to offer visitors a more fulfilling experience. It increases the chance of a longer visit or a return visit, therefore allowing citizens to stay in connection with nature.

This study did not consider animal welfare aspects and neglected the functionality of the exhibits for zoo staff. Consideration of whether animals can live a healthy life while demonstrating natural behaviours and whether zoo workers are able to carry out their daily routine is also important. Further research should look at these questions. In addition, to further clarify the current results, future studies should consider differences between morning and afternoon records, the effects of number of individuals and exhibit sizes (i.e. animal density), and be extended to other research areas and taxonomic groups.

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