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Activity Budgets and Time Treatments of Lion (*Panthera leo*) Cubs under Human Imprinting at Antelope Park, Gweru, Zimbabwe

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Abstract In African Lions Panthera leo, human imprinting was suggested as one option of pre-release training of orphaned cubs, but success of this option has rarely been explored. This study assesses the success of human imprinting on captive-bred lion cubs at Antelope Park in Gweru, Zimbabwe. Activity diversity, activity budgets and response to non-wild objects were compared in three levels of human imprinting (high, medium and low) using the focal technique. Six lion cubs were used for this study (two in each imprinting category). Data were collected during early morning, mid-morning and late afternoon sessions from October to November 2011. In the three levels of human imprinting, resting and locomotion had the largest proportion of time compared to playing, visual exploration, feeding, human interaction and hunting. Lion cubs with low imprinting displayed the most "hunting instincts" and aggressive behaviour toward humans and vehicles, compared to those with high and medium imprinting levels. At the age of the cubs under study (9~13 months) hunting was not expected to be successful, but the display of some hunting instincts was encouraging in the high and medium imprinted cubs. Although the small sample size used in this study and the need to continue monitoring the cubs restrict conclusions that can be made from this assessment, such early signs of the success of human imprinting could be encouraging for human imprinting.

Keywords Human imprinting; Behavioural enrichment; Reintroduction; Captive breeding; *Panthera leo*

Introduction

A haDeclining numbers of top carnivores such as the African Lion, Panthera leo, are threatening ecosystem functioning and integrity (Otto et al., 2008). In conservation efforts to save threatened species, reintroduction is one of the last resorts for wildlife managers to employ (Jule et al., 2008). In felids, reintroduction programs are challenged by a deficiency of critical behaviours such as hunting (Håkansson and Jensen, 2008). Pre-release training is therefore critical to enhance survival of individuals re-introduced into their former ranges (Ncube and Ndagurwa, 2010). Despite difficulties such as the space required for training (Shepherdson, 1998), negative public reactions (Mcphee, 2002), high costs, and animals adapting to novel conditions around them (West et al., 2006), pre-release training remains a viable way of training animals prior to reintroductions (Jule et al., 2008). The African Lion and Environmental Research Trust (ALERT) started practising it in 2005 for lion cubs at Antelope Park, Zimbabwe, 2007).

This study assesses the effectiveness of human imprinting as a behavioural enrichment tool for lion cubs at Antelope Park. First, it was hypothesised that the cubs with low imprinting levels (being trained by a wild pride) would show greater activity diversity, exhibit more hunting instincts, and react more aggressively to non-wild elements in comparison to those trained by human. Second, it was presupposed that activity patterns of low level imprinted cubs would be

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similar to those of the wild pride from which they were learning their life skills while the high and medium level imprinted cubs' patterns are likely to be greatly influenced by the time schedules associated with human imprinting treatments. Accordingly, the focus of this work was to compare the activity diversity, time allocation (activity budget) and response to non-wild elements between semi-wild cubs (orphaned cubs developing in a wild pride) and socially-deprived captive-bred lion cubs (human imprinted) at Antelope Park in Gweru, Zimbabwe.

1 Results

A total of 13 different cub activity types were observed during the study period. There was no significant difference in the diversity of activities among imprinting levels ($F_{(1,2)}$ = 0.360, p=0.552), but there were marginally significant differences in the activity diversity with session ($F_{(1,2)}$ = 3.082, p= 0.057), the early morning, mid-day and late afternoon sessions having Simpson's diversity indices of 0.566, 0.458 and 0.385 respectively.

1.1 Activity budgets

In the early morning session, the low-imprinted lion cubs had significantly higher levels of resting and hunting, although time allocated to locomotion was the least in comparison to the high and medium imprinted cubs (Table 1). In the mid-day session, resting was the dominant activity, but the low-imprinted lion cubs had more than double the resting time relative to the high and medium imprinted ones (means of 23.17, 11.73 and 12.72 minutes respectively), and this trend was similar in the late afternoon sessions (see Table 1). In the late afternoon, the high and medium imprinted lion cubs continued to have significantly high locomotion levels compared to the low imprinted ones (means of 28.24, 27.94 and 10.5 minutes respectively). Visual explorations were significantly higher in the low-imprinted cubs (mean 9.4) than in the high and medium ones (means of 5.2 and 2.5 minutes respectively). However, among all three sessions, the amount of time allocated to playing, human interactions and feeding was not different in any cub types (p>0.05 in all cases).

Table 1 Mean rank of time (mins) allocated to different main behaviours in the three sessions

Session	Activity	Cub description	N	Mean rank	H-value	P-value
Early morning	Resting	Semi-wild	19	42.68[a]		
		Captive far from camp	20	20.5[b]	21.83	< 0.001
		Captive near camp	17	22.06[b]		
	Locomotion	Semi-wild	13	9.92[a]		
		Captive far from camp	19	32.71[b]	20.617	< 0.001
		Captive near camp	18	29.14[b]		
	Hunting	Semi-wild	7	9.71[a]		
		Captive far from camp	4	3.25[b]	7.658	0.022
		Captive near camp	2	5[a,b]		
Mid-day	Resting	Semi-wild	6	23.17[a]		
		Captive far from camp	13	11.73[b]	8.556	0.014
		Captive near camp	9	12.72[b]		
	Visual exploration	Semi-wild	4	5[a]		
		Captive far from camp	6	8.67[a]	2.024	0.364
		Captive near camp	4	8.25[a]		
Late afternoon	Resting	Semi-wild	16	45.91[a]		
		Captive far from camp	21	19.79[b]	31.126	< 0.001
		Captive near camp	17	19.71[b]		
	Locomotion	Semi-wild	12	10.5[a]		
		Captive far from camp	17	27.94[b]	15.234	< 0.001
		Captive near camp	17	28.24[b]		
	Play	Semi-wild	3	7.67[a]		
		Captive far from camp	8	8.88[a]	0.377	0.828
		Captive near camp	6	9.83[a]		
	Visual exploration	Semi-wild	5	9.4[a]		
		Captive far from camp	5	5.2[b]	6.346	0.042
		Captive near camp	2	2.5[b]		

Note: *Different superscripts (a, b) in each activity row indicate significant differences in the mean ranks. In each activity row where N < 12, the results were excluded

1.2 Reaction to non wild objects

Reaction of high, medium and low imprinted lion cubs to humans was marginally different (Mann-Whitney U(109) = 5118, Z = -1.974, p = 0.048). The low-imprinted cubs almost always reacted in aggressive ways to approaching humans, while the high and medium imprinted cubs had more neutral-receptive responses (Figure 1A). Similarly, reaction of cubs to vehicles in the three imprinting levels was significantly different (Mann-Whitney U(57) = 72, Z = -9.096, p < 0.005), where the low-imprinted cubs showed no receptive gestures to vehicles, unlike the high and medium imprinted cubs (Figure 1B).

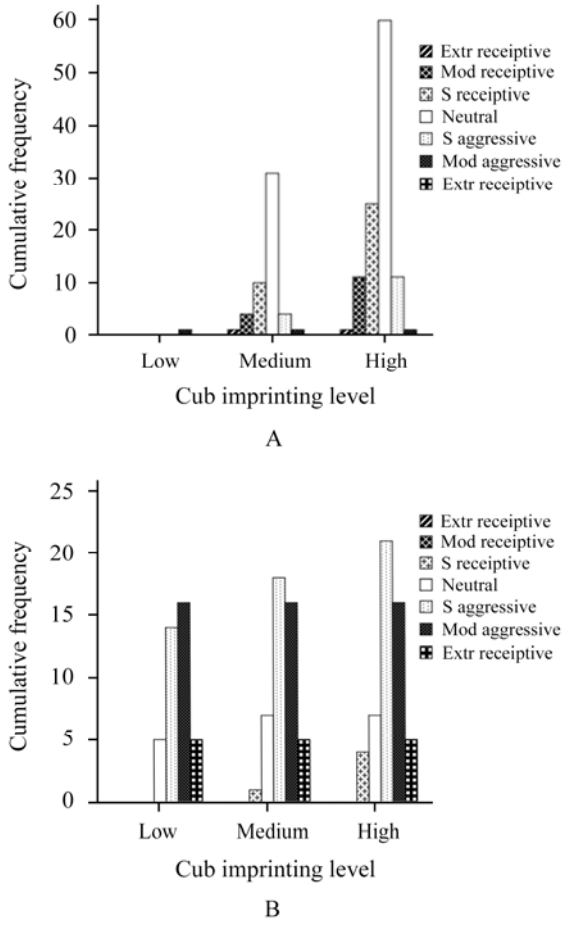

Figure 1 Cumulative frequencies of reactions made by semi-wild and captive lion cubs to non-wild elements

Note: (A) approaching humans and (B) vehicles. In the key, S = slightly, Mod = moderately and Extr = extremely

2 Discussion

2.1 Activity budgets

This snapshot assessment revealed that the low-imprinted cubs spent more time resting in comparison to the high and medium imprinted ones, which is consistent with results by Ncube and Ndagurwa (2010). This was expected, since lions in wild prides (in which our low-imprinted cubs were being trained) spend at least 20 hours per day mostly resting (Parker and Pusey, 2005). Contrasting results by Hayward and Hayward (2007), showing that lions at Addo elephant Park tend to be active for the whole 24 hours of the day, could possibly have been confounded by the definition of "active behaviour" used in that study (i.e. movement of more than 100 m in each hour), which could merely be a change of resting site in search of better shade.

The high and medium imprinted lion cubs were more locomotive than the low-imprinted ones during the mid-day sessions. This could possibly be due to boredom or to the presence of humans: it has been shown that captive animals pace up and down repeatedly when bored (Pitsko, 2003), and locomotion can also be stimulated by the presence of humans, which is associated with feeding and behavioural enrichment activities (Lindsey et al., 2012). The cubs' boredom could possibly be amplified by the small size of enclosures (less than 2.02 km^2 for all lion cubs used in this study) in contrast to the 20~200 km^2 home ranges required by wild lion prides (Bashaw et al., 2003).

Contrary to our predictions, there were no differences in the expression of hunting instincts in the late afternoon sessions. This could be attributed to the longer time it might take for low-imprinted cubs to acquire the necessary hunting skills from the wild pride (Hunter et al., 2012), and it is also possible that the behavioural imprinting on the captive cubs has had some low level of success in stimulating hunting instincts similar to those being raised in the wild pride (Bateson, 2003). However, we think that the lion cubs in this study were also too young (9~13 months) to have gained enough confidence to hunt; at this age they are normally expected to be observing and imitating the older members of the pride, they only start to be involved in hunting after 18 months (Kokes, 2010). In addition, our study reveals behavioural patterns observed over a very short space of time. More conclusive results can be obtained if monitoring is continued as the cubs grow.

In trying to avoid boredom, cubs may increase their activities under human imprinting (Mcphee, 2002). For example, Ncube and Ndagurwa (2010) revealed that orphan-raised cubs (with high levels of imprinting) displayed more hunting instincts than mother-raised ones. In view of the ultimate goal to re-introduce these lion cubs into the wild, the important issue is for the cubs to be able to successfully hunt and kill prey sustainably for their survival. Current success rates of about 1 kill per month by the medium-imprinted cubs (statistics from park management) are not sufficient for survival in the wild where there may be increased competition from other predators (Periquet et al., 2012) or where the prey are well adapted to escape (Cooper and Frederick, 2007).

The observed insignificant difference in the diversity of activities among the three levels of imprinting could possibly be explained by a number of factors. Previous studies found that factors such as enclosure size (Baldwin, 1991), enclosure complexity (Kokes, 2010), behavioural enrichment, and geographical location (Ncube and Ndagurwa, 2010) affect diversity of activities. The enrichment activities (e.g. lion walks, hunts etc.) could possibly explain why activities in the "less efficient" human-imprinted cubs matched those of "more efficient" wild pride-trained cubs.

2.2 Reaction to non wild objects

The low-imprinted cubs always reacted in aggressive ways to approaching humans, while the captive-bred cubs had more neutral to receptive responses. This was expected given the low human contact in the low-imprinted cubs compared to the high and medium imprinted cubs, which could be habituated to humans carrying out husbandry chores (Fagen and Fagen, 2009), or the excitement of being taken out on walks (Hunter 1998) and to tourist visiting. Although difficult to implement, aggressive behaviour against non-wild objects (such as vehicles or humans) must be encouraged in human-imprinted cubs if they are to be re-introduced, as this will help to reduce poaching (particularly local unarmed poachers) and promote identification of natural enemies.

In other studies, cubs having high stress levels performed energetically costly behaviours such as sitting up or pacing up and down (Hayward and Hayward 2007), and in tigers they increased vigilance (Pitsko, 2003), but we did not observe any of these "stress-related" behaviours during our data collection sessions. We therefore suggest that the cubs had low stress levels, which can possibly be attributed to the enrichment programme.

3 Methods

3.1 Study area

Antelope Park (29º 09` E, 19º 28` S) is a 12.14 km^2 private game reserve with a lion breeding facility for training and releasing captive-bred lion cubs back into wild environments. The mean annual rainfall range is 948~1 420 mm and mean annual temperature range is 4~38.9 ℃ (Ncube and Ndagurwa, 2010). The area is open grass mixed woodland dominated by acacias and hosts 23 mammalian species, commonly plains zebra (*Equus quagga*), impala (*Aepyceros melampus*) and blue wildebeest (*Connochaetes taurinus*).

3.2 Enclosure and study individuals descriptions

Three pairs of cubs were used in this study. The first pair was in an enclosure about 500 meters away from the safari camp (these had a clear view of humans and activities around the camp). The second pair was in an enclosure 2 km away from the camp (could not see or hear humans except during enrichment programs, feeding and cleaning times). The third pair of cubs was in a semi-wild, 2.02 km^2 enclosure about 4 km away from the safari camp (introduced into a "wild" pride of 4 lions where human contact was restricted to encounters during ethological observations only). Since increased exposure to humans is expected to increase imprinting in lion cubs (Kokes 2010), cubs that were 500 meters, 2 km and 4 km away from the camp are referred to as having high, medium and low levels of imprinting respectively.

3.3 Behavioural observations

Lion cubs were observed during the early morning (0630~0830 hrs), midday (1100~1300 hrs) and late afternoon (1600~1800 hrs) during October~November 2011, which is just a snapshot of cubs' behaviour during the enrichment exercise. Following the focal animal sampling technique by Altmann (1974), a cub was randomly chosen, and the amount of time (in

minutes) it took performing particular activities was recorded in the 2-hour session. All behavioural activities were classified into seven distinct categories (resting, feeding, playing, locomotion, visual exploration, hunting and human interaction as described by Kokes (2010). The focal sampling was conducted from at least 70 meters using binoculars to minimize the observer's influence on the cub's activity. After the focal observations, cubs were approached from a vehicle or on foot and the one-zero sampling technique was used to rate their response on a seven point scale (0~6), where 0 = extremely receptive; 1 = moderately receptive; 2 = slightly receptive; 3 = neutral; 4 = slightly aggressive; 5 =moderately aggressive and 6 = extremely aggressive.

3.4 Data analysis

From the observation sessions, the total time spent by each cub displaying a particular behavioural activity was summed up per session. The data failed to meet normality assumptions even after transformation attempts, therefore the Kruskal Wallis test was used to test for differences in the amount of time allocated to different activities in the three sessions (early morning, mid-day and late afternoon). For each activity, the Mann-Whitney test was used to make post hoc pairwise comparisons of the mean ranks in the three levels of human imprinting (high, medium and low).

Using the number of different activities recorded during the focals, the Simpson's diversity index was calculated for the behavioural activities per cub in each session. Since the distribution of this diversity data did not significantly differ from normal, a 2-way ANOVA was used with session (early morning, mid-day and late afternoon) and cub imprinting level (low, medium and high) as factors to test for differences in activity diversities.

3.5 Implications for conservation

We concede that it is far too early for us to judge the success of human imprinting as a way of pre-release training based on the findings of this study. However, the similar levels of diversity of activities and hunting instincts displayed by the three levels of imprinting offer a ray of hope in using human imprinting as a behavioural enrichment for successful reintroduction of captive-bred lions. Our study, like most outdoor experiments, lacked a perfect control set of naturally living wild cubs, compelling us to use a correlation approach, which has been criticised for revealing patterns but not causation (Dowling and Richardson, 2001). We recommend that continuous monitoring is required throughout the development stages to meticulously evaluate the success of human imprinting if it is to be adopted as standard procedure in lion captive breeding and reintroduction programs.

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