How to Describe the Process of the Establishment of a Social System Within a Wolf Pup Model Group Using Traditional Ethological Indexes and the Detection of Hidden Patterns

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Abstract

The present study compares what can be shown in the process of wolf pup social system establishment with traditional ethological methods; (index of individuals association, index of synchronization of activity, distances between sleeping individuals, sociograms, and the variability of contact intensity) and also with the detection of hidden patterns, Theme (Noldus Information Technology) was used for this purpose. A simple social group of four growing pups which were kept in captivity and were used as a test model, the sample is 2 groups.

Keywords. Social system development, observational methodology, T-patterns, group behavior, traditional ethological methods, comparison of methods

Introduction

The first social influence in animal life is the maternal influence, but siblings are important also for developing the behavior of each other in ontogenesis. Therefore the purpose of investigating the reciprocal influence of the same age younglings is a matter of most importance.

Social environment is the most predictable factor on the one hand, though it is difficult to detect changes in it sometimes, but on the other hand, it is very important for the individuals survival for all of its' life. [3, 5, 12]. How can small pups organize their complex social system as elements? How can the observer measure this process? It is important to find the methodological way of describing and analyzing the ontogenesis of social connections in a group from all perspectives of the dynamics. Classical and traditional methods of measuring of the social connections between animals exist [2, 6, 8, 10, 11]. But they cannot illustrate the full picture, just shed light on some principal moments or describe different aspects with a unidirectional outlook. If we try to look at the social group as a complex functional system, where animals are elements of it we have to understand how uninterruptedly the behavior of every animal is organized in the flow of time and how it is connected with the behavior of all other animals within the group. Hidden patterns can show this type of organization; and their dynamics shows how it evolves over time. When the social structure changes with the animals and their relations development then other elements with other connections between them build the hidden patterns that can be defined. This methodology was successfully applied for the analysis of human communication in different ways [1, 13], we tried to test how it works in social animals living and developing within a group.

Aims

The aim is to study how to explain completely the process of the simple social system of four wolf pups development during their ontogenesis. The main purpose of the paper is to illustrate the changes in the social structure situation during establishment by using six categories of methods (traditional indexes and hidden patterns). Other purposes are to test how such an observational instrument can be applied for such measurement; to compare methods that we have used.

Methods

Two model groups each of four animals were investigated. We had two males and two females of the same age in each group. We received the animals from zoos at the age of twenty-five days old, after the imprinting phase of socialization; in one group we united animals from two different litters before the beginning of collecting behavioral data. We raised the animals in big enclosures, square of up to one hectare in size, which were just parts of a natural forest with a rich habitat. Animals were not handled, but were raised without parents by humans; they knew personally all observers and behaved themselves naturally but this kind of behavior they did not extrapolate toward all people generally. We collected data in three ways: (1) made 24 hour observations once a week, recorded information on a dictaphone every 1 minute for each animal – a method of time steps was used for this; (2) collected video data – each animals behavior was filmed during a period of 10 minutes with focal observation method; (3) made 6 hour observations describing all behavior and interactions, recorded information on to a dictaphone – continuous logging. Different types of data collecting used in different days. We collected 927 hours of Dictaphone recorded observations and 20 hours of video for group #1; 281 hours of dictaphone observations and 18 hours of video for group #2. The wolf pups were under observation for the age period of between thirty five days and four and a half months.

Instrument

During 24 hour observations we recorded types of activity. There were two activity categories: individual types of activity and social types. The first category included: sleeping, resting, moving, manipulation of objects, feeding, excreting, comfort activity, activity of orientation and tracking of observer (human). Second category: contact with observer, consolidation of pups, agonistic activity, friendness activity, following each other, avoidance of each other, play, stress reaction, and reaction to an unknown stimulus If two senses of behavioral actions were observed, we registered the activity type that had a more definitive motivational indication and was strongly shown in the morphology of behavior [9].

Data analysis

Traditional methods of social connection estimation

We used five types of indexes for estimating the level of social connection between animals. Three of them are often used for analyzing behavior in dyads; namely: index of activity synchronization; index of individuals' association and distances between individuals during sleeping time. For counting the index of activity synchronization for the one type of activity we used formula $\boldsymbol{I}_{syn\text{-}AB\text{-}actviv}$= $\mathrm{Sum}_{\boldsymbol{Syn}}$/ ($\mathrm{Sum}_{\boldsymbol{A}}$+$\mathrm{Sum}_{\boldsymbol{B}}$). Here $\mathrm{Sum}_{\boldsymbol{Syn}}$ – quantity of time steps when individual's *A* и *B* had the same activity type; $\mathrm{Sum}_{\boldsymbol{A}}$ or $\mathrm{Sum}_{\boldsymbol{B}}$ – summary of time steps with this type of activity during 24 h for *A* or for *B* only. If *A* with *B* are fully synchronized, then index meaning should be 0,5. For counting the index of individuals' association we used *Ia=Nab/(Nab+Na+Nb)* formula. Here *Nab* – summary of cases of observation, when *A* and *B* were together; *Na* – counted cases of observation, when *A* was without *B; Nb* – counted cases of *B* without *A*. Maximum meaning of index is 1 – animals are together every time, minimum meaning is 0 [11]. For analyzing distances during sleeping time, we allocated distances of 6 types: "close contact"; "touching"; "animals are close; but without touching" (less than a length of a body between them); "nearby" (from 1 to 5 lengths of a body); "far" (more than 5 lengths of a body); "too far" (out of a visibility). We counted all categories of the sleeping distances frequency and the dynamics of it. 282 sleeping periods were analyzed in all.

Two other types of estimation of social bonding changes were sociograms and distribution of partners during interactions. We pictured a system of interactions as classical sociograms through analyzing the video-files; the social ranking of the animal was recorded from it (α, β) as classical ethological works describes [4, 14]. Index of individuals rank counted as $I_{rank}=(Sum_{in}-Sum_{get})/(Sum_{in}+Sum_{get})$, where Sum_{in} – summary of all initiated contacts, Sum_{get} – summary of all contacts was received by the animal from all others. Sociograms were made for all positive, negative and neutral contacts. When the frequency of distribution of partners during interactions was counted, we took all 15 variations of animals' combinations: not only dyads, but trios and all-together group contact.

Hidden patterns analysis

Data of four pups 24 hour activity for four months ontogenesis period were analyzed using Theme v. 5 (NOLDUS); the retrieving patterns were allocated to data base Theme v. 6 (beta version). The algorithm was made for hidden T-pattern detection [7]. In one event, we used information about the author of activity, beginning or ending of activity, type of activity, partner for this activity. Example of one event: dunai,b,agon, dn (wolf Dunai begins his fight with wolf Nika). All patterns consist from such events, which are connected. We used p-level < 0.005 for pattern detection; minimal occurrence for pattern means 5.

A pattern can be written as a line: (((dunai,b,agon,dn_dunai,e,agon,dn) rada,b,play,ar)(amur,b,play,and amur,e,play,and)) or as a tree-scheme (Figure 1). The tree-scheme shows the events occurring within the pattern, listed in the order in which they occur in the time. The first event in the pattern appears at the top and the last at the bottom. The pattern diagram (the lines connecting the dots) shows the connection between events. This example pattern consists of two blocks of events (3&2). If read we have: male Dunai begins fight with female Nika (1) and ends it by himself (2); next event that was in the time after these is connected with these two – female Rada begins to play with male Amur (3); other two events that were in the time after previous three are connected with all described block – male Amur begins to play with other male Dunai and female Nika (4) and ends it by himself (5). This all has behavioral sense that the agonistic interaction of two pups can provoke the behavior of reconciliation, initiated by others consistently; such pattern was repeated more than 5 times in a 24h period.

So we can analyze in such away all the patterns as they appear in the animal's ontogenesis with relationships between individuals developing. For this, we have to make a table with line-written patterns in the order that they appear in ontogenesis, the example is shown in Table 1. It is simpler if you organize patterns with some characters. For example through SQL we can have all patterns with agonistic or playing activity only. When we analyze patterns from this table by sense in their order, we can have the total picture of the social situation in group developing and establishing. In this way patterns with agonistic, friend and playing behavior were analyzed. Then all results of all methods were used combined for a resulting picture of relations between animals establishment understanding.

Comparison of the methods which were used

We compared methods which we used to understand which method that behavior characteristics could describe in a better way. We tested the contribution of different methods with discriminant, cluster and factor analysis. With cluster and factor analysis, we compared results of the index of synchronization of activity; index of animals' association and quantity of inclusiveness of pairs of animals in the patterns structure. With discriminant analysis we compared quantity of inclusiveness of individual in all patterns; in friend, agonistic and playing patterns as author of activity; inclusiveness of individual in all patterns as recipient of activity (these all were dependent variables), which were discriminated by sex, rank status, individual, litter and age period of development (independent variables).

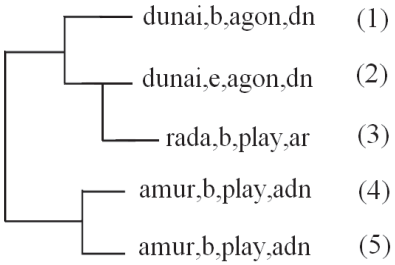

Figure 1. Tree-scheme of one hidden pattern type from 24.08.2008 for investigated wolf pup group #2, pattern was repeated 7 times on the day it was allocated. Rada, Dunai, Amur – names of wolf pups; b/e – begin or end of activity; agon/ play – agonistic/playing type of activity, dn/ar/adn – first letters of interacting wolves' names: dunai-nika/amur-rada/amur-dunai-nika.

Table 1. Example of table with hidden T-patterns where playing behavior is included. Results for wolf pup group #2. nika, amur, dunai, rada – pups names; b/e –beginning or ending of activity; rest, play, move, manip – types of resting, playing, moving or manipulation with objects activity; and, dr, all – combinations of first letters of interacting pups names – amur-dunai, dunai-rada; all (all 4 pups together).

Pups' age (days)	Pattern
37	(nika,e,rest,and ((amur,b,move,a_rada,e,rest,r) (dunai,b,play,dr_dunai,e,play,dr)))
50	(((nika,e,comf,n rada,b,agon,nr) amur,b,play,an) (amur,e,play,an dunai,e,manip,d))
50	((amur,b,orient,a nika,b,play,nr) (nika,e,play,nr(amur,e,manip,a_rada,e,move,r)))
58	((amur,b,manip,a rada,e,manip,r) ((dunai,b,play,ad (dunai,e,play,ad nika,b,play,dn)) (dunai,e,play,dn nika,e,play,dn)))
58	((rada,e,manip,r (nika,e,manip,n rada,e,play,ar)) (amur,b,mark,a_amur,b,rest,a))
68	(nika,e,manip,n (((nika,b,manip,n rada,b,play,dr) (dunai,b,play,dr rada,e,play,dr))(rada,b,comf,r rada,e,comf,r)))
76	(((nika,b,play,nr nika,e,play,nr)(amur,b,manip,a rada,b,manip,r)) (amur,e,manip,a ((dunai,b,manip,d dunai,e,manip,d) (amur,b,orient,a nika,e,orient,n))))
76	((rada,b,play,dr rada,e,play,dr) (((amur,b,move,a amur,e,move,a) amur,b,manip,a) (amur,e,manip,a (dunai,b,manip,d nika,b,manip,n))))
86	((amur,b,play,ad dunai,b,play,adr) ((dunai,e,play,adr (dunai,b,play,all rada,b,play,all)) (nika,b,play,all (amur,e,play,all dunai,e,play,all))))
86	(nika,b,play,all ((amur,b,play,all rada,e,play,all)(amur,e,play,all (dunai,b,play,adr dunai,e,play,adr))))
95	(((dunai,b,move,d nika,b,orient,n)(nika,e,orient,n rada,e,orient,r)) (nika,e,move,n (rada,b,play,r rada,e,play,r)))
95	((dunai,b,play,dr dunai,e,play,dr) ((amur,b,manip,a nika,b,manip,n) (dunai,b,move,d nika,e,manip,n)))
101	(rada,b,play,all ((amur,b,play,all amur,e,play,all) (rada,e,play,all (dunai,e,play,all rada,b,manip,r))))
110	((rada,b,play,nr (nika,b,play,nr nika,e,play,nr)) ((amur,b,play,all amur,e,play,all) dunai,b,play,and))
110	*(((dunai,b,agon,dn dunai,e,agon,dn) rada,b,play,ar) (amur,b,play,and amur,e,play,and))*
124	((dunai,b,move,d (dunai,e,move,d rada,e,move,r)) (nika,b,play,nr nika,e,play,nr))
135	(nika,b,play,all (amur,b,play,all amur,e,play,all))

Results

(1) Traditional methods can show the most important moments of social situation in group changes in the time scale during development. For an example period, when animals became a group, this event takes place in nonlinear way in the wolf pups aged 68-110 days. The Index of synchronization of activity can show that dependence between two animals exist, but cannot show the character of this dependence. Index of association of the individuals can show intensity in attachment in pairs of individuals, but it is oriented much toward the pups from one litter. Distances between sleeping individuals shows periods when animals were especially close and these dynamics have a difference of a period of 5-7 days delay with the dynamics of indexes described above. Using Sociograms we can imagine how the social system looks from the hierarchical point of view. (2) Hidden pattern analysis can show all nuances of process of social structure establishment. In the beginning when group is not structured and pups do not have an opinion about each other there is less agonistic activity in patterns and pups play as pairs (as patterns show); then ranking position of the α-male is allocated; after that it is the beginning of the social position of β-male appearance and ranking position of α-female allocation; after that all group units as a whole; than social position of β-male establishes and after social positions of β-female allocation – primary social group system becomes stabilized. (3) When comparing methods it is the indexes, which describe better variability of connections in pairs than patterns. Methods are not interchangeable, they describe situation differently, and they do not repeat the results of each other (factor and cluster analysis has shown this). With discriminant analysis we tested only pattern characteristics. Inclusiveness of the individual to all patterns as an author of activity and as a connected recipient better describes the individual's characteristics:

rank status, sex, litter. Intensity of inclusiveness of the individual in patterns with playing, agonistic and friendless activity better describes the periodization of development.

Conclusion

When we describe ontogenesis or the structure of group establishment we have to use different methods. But the full picture can be shown if combine all results of the different methods together, because different aspects are specified with them. Using T-pattern analysis we have opportunity to describe such processes like the social position of a female allocating this with a mathematical significance. This method seems to be very promising. Though it describes a social connection between animals in dyads poorly when compared to the use of classical indexes, it has worked out for the use of complex analysis, so it can show a picture of a real situation and the processes in reality. This type of analysis is independent and separate (as cluster analysis has shown), we cannot use it instead of classical ethological indexes, and we cannot reliably replace these old analyses with the more modern T-pattern analysis. We have different types of information resulting from them, but we can combine them. We can use the same patterns for analysis in different aspects to understand features of the wolf pups development or the features of individuals' behavior, or picturing their social system.

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