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Electronic Supplementary Material
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Title: **Social factors mediating human–carnivore coexistence: Understanding thematic strands influencing coexistence in Central Romania**

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Appendix S1. The interview guide used for semi-structured interviews with 71 people (original in Romanian).

1. The following questions will ask about your experience with bears

Please indicate how often:

1.1 You see a bear
a) never b) rarely c) several times a year d) often

1.2 A bear damages your fields and/or orchards, and/or beehives
a) never b) rarely c) several times a year d) often e) not applicable (no fields/orhards/beehives)

1.3 A bear attacks your animals
a) never b) rarely c) several times a year d) often e) not applicable (no animals)

1.4 Which other animals cause problems in the village? Do you think these problems are worse than the problems caused by bears?
_____
_____
_____

2. (Traditional ecological) knowledge on how to live with bears

Romania is a special country regarding bears because it has one of the largest populations in Europe. Furthermore, Transylvania is especially unique, because people and bears live alongside each other and share the same landscapes. This is very different from Western Europe. There are few bears in Western Europe, and in many places they have been hunted to extinction. However, at the moment in many places bears are returning to Western Europe. Therefore, we would like to know and learn more on how you manage to live together with bears in Transylvania.

2.1 How do you manage to live together with bears?

2.2 Where and how do you learn to share a landscape with bears?

3. Which factors could disturb human-bear relationships

The Transylvanian country side has changed rapidly over the last years. For example, tourism from foreign countries has increased and the architecture of the houses has changed. In your opinion, are there certain changes that have changed or might change the relationships between humans and bears?

3.1 Do you think the way people and bears live together now is different from the past?

3.2 Do you think people and bears can live together in this region in the future?

3.3 What do you think are the major factors that could change the way people currently live with bears?

4. Cultural values and attitudes towards bears

In some countries bears are important for their culture and there are stories and believes around bears. For example, Sleeping Bear Dunes, a huge sand dune in America, is named after a Native American legend. A female bear and her cub swam across a big lake (Lake Michigan). Exhausted from their journey,

the bears rested on the shoreline and fell sound asleep. Over the years, the sand covered them up, creating a huge sand dune. Or for example, in Finland and Russia the bear is the national animal. In your opinion, does the bear play an important role in your culture?

4.1 Are bears an important part of your culture?

4.2 Can you remember any particular stories that include bears? Which one and what kind of character did the bear have?

Germany and Switzerland have had similar recent experiences with bears. In both countries one bear came back and lived in the country for a while. However, in both countries they decided to shoot the bear as it was classified as a problem bear and a threat to human safety. How do you feel about this approach?

4.3 What would you do in this case? What are your feelings in general towards bears?

4.4 Do you think it is important that bears persist in the Transylvanian landscape in the future?

5. Management of bears

Not everybody in a country, region or village is affected in the same way by sharing the landscape with bears. Do you think that there are any benefits or disadvantages of sharing the landscape with bears?

5.1 Are these benefits or disadvantages equally distributed between community members?

5.2 Do local authorities/hunting associations help to prevent damage caused by bears? Do they take care to close the difference in the distributions of benefits/disadvantages indicated in the previous question?

People living in countries that lack large carnivores such as bears are often very impressed by the presence of these animals. Therefore, many countries have developed tourism based on large carnivores. This includes guiding tourists around the landscape with the chance to see and photograph carnivores, or tourists pay for a license to hunt for carnivores and they can take home the fur and parts of the skeleton (trophy hunting). Are there any of these examples present in your village?

5.3a If yes, are they managed well and does the community benefit from this? Who benefits?
5.3b If no, do you see a future for tourism based on bears in this region?

The following questions are with respect to you

i. Gender: a) M b) F
ii. Age:
iii. Profession
iv. Ethnicity: a) Romanian b) Hungarian c) Roma d)Saxon
v. Where did you grow up: a) this region b) a different region, but with bears present
c) a different region without any bears present

Thank you very much for your participation!

Appendix S2. The questionnaire used for 252 people (original in Romanian).

Please indicate how often:

1. You see a bear
   a) never b) rarely c) several times a year d) often

2. A bear damages your fields/orchards/beehives
   a) never b) rarely c) several times a year d) often e) not applicable

3. A bear attacks your animals
   a) never b) rarely c) several times a year d) often e) not applicable

The following questions will ask if you use any protective measures against bears

Please indicate:

4. Do you use protective measures to prevent damage to fields/orchards/beehives
   a) no b) occasional c) yes d) not applicable

5. Do you use protective measures to prevent bear attacks on your animals
   a) no b) occasional c) yes d) not applicable

6. I go into areas where bears are present
   a) no b) occasional c) yes

7. In my daily life I try to prevent getting into conflict with bears
   a) no b) occasional c) yes

The following questions are general questions about bears

Please answer the following statements to your best knowledge:

8. Bears mainly feed on meat a) yes b) no

9. Female bears have young every year a) yes b) no

10. Most bears weigh more than 150 kg a) yes b) no

11. Bear cubs leave the mother in their first year of their life a) yes b) no

12. Bears are protected animals in Romania a) yes b) no

The following questions will ask about how you achieve knowledge about bears

Please indicate the extent to which you disagree or agree with the following statements:
1 = strongly disagree; 2= disagree; 3 = neutral; 4 = agree; 5 = strongly agree

13. My parents told me how to live in a landscape with bears 1 2 3 4 5

14. At school we learned about bears and how to live with them 1 2 3 4 5

15. Local authorities provide information on how to live with bears 1 2 3 4 5

16. Local NGO's provide information on how to live with bears 1 2 3 4 5

17. What I know about bears, I learned from experience 1 2 3 4 5

The following questions will ask about bears in your culture

Please indicate the extent to which you disagree or agree with the following statements

18. Bears are important in our culture 1 2 3 4 5

19. Hunting bears is important in our culture 1 2 3 4 5

20. I grew up hearing stories about bears 1 2 3 4 5

21. In the stories I know, bears mainly have a positive character 1 2 3 4 5

22. It is important for our culture that bears persist in the landscape 1 2 3 4 5

The following questions are regarding your feelings towards bears in general

Please indicate the extent to which you disagree or agree with the following statements

23. I generally like bears 1 2 3 4 5

24. It is bad to have bears in Transylvania 1 2 3 4 5

25. Bears should remain part of our landscape in the future 1 2 3 4 5

26. I am afraid to meet a bear 1 2 3 4 5

27. Bears do not have the same rights as humans to exist in the landscape 1 2 3 4 5

The following questions are regarding the usefulness of bears in the landscape

Please indicate the extent to which you disagree or agree with the following statements

28. Bears have a negative impact on hunting opportunities 1 2 3 4 5

29. In areas where there are bears and sheep, bears kill a lot of sheep 1 2 3 4 5

30. Bears damage a lot of orchards and fields 1 2 3 4 5

31. Bears are dangerous to humans 1 2 3 4 5

32. Bears increase the value of a hunting area 1 2 3 4 5

33. Having bears increases tourism in the area 1 2 3 4 5

34. Bears keep the forest clean of dead and sick animals 1 2 3 4 5

35. Bears keep nature in balance 1 2 3 4 5

The following questions are regarding the management of bears

Please indicate the extent to which you disagree or agree with the following statements

36. Bears should be completely protected	1	2	3	4	5
37. Local authorities put in enough effort to prevent damage by bears	1	2	3	4	5
38. Hunting associations put in enough effort to prevent damage by bears	1	2	3	4	5
39. I would like to be involved in the management of bears in the area	1	2	3	4	5
40. We receive compensation for damage by bears	1	2	3	4	5
41. Trophy hunting benefits the entire community	1	2	3	4	5
42. Hunting bears should be possible to everybody in the community	1	2	3	4	5

The following questions are about your opinion on how humans and bears share the landscape

43. In your opinion, how do bears and humans live together in this region
    a. Peacefully without conflicts
    b. Relatively peacefully with tolerance for occasional conflicts
    c. Relatively unpeacefully due to occasional conflicts
    d. Unpeacefully due to escalating conflicts

44. In your opinion, how do you see the relationship between humans and bears in the future?
    a. Better
    b. Worse
    c. No change

45. Explain shortly your answer under question 44

    _____
    _____
    _____

46. Would you like to add any additional information about bears?

    _____
    _____
    _____

The following questions are with respect to you

i. Gender: a) M b) F
ii. Age:_____years
iii. Profession
iv. Ethnicity: a) Romanian b) Hungarian c) Roma d)Saxon e) Other, namely:
v. Where did you grow up: a) this region b) a different region, but with bears present c) a different region without any bears present

Thank you very much for your participation!

Appendix S3 - Questionnaires for an overview on perceptions of human-bear coexistence

Appendix S3 presents the methods, findings, and their implications, related to the questionnaires used to assess general patterns of human-bear coexistence.

Methods

In accordance to a methodological triangulation approach we also used quantitative methods to assess different perspectives on the topic of coexistence. We used questionnaires to obtain an overview of general patterns in the social drivers affecting people's perception of human-bear coexistence. We assessed combinations of predefined social factors influencing people's perception of current and future coexistence. Questionnaires are useful when the researchers know what they are seeking, to obtain an overview of related average opinions and simplify the comparison between respondents by enabling quantitative analyses (Huntington 2000). We based questions on social factors found in the literature which we deemed relevant and adapted them to our study area, including socio-demographic factors (e.g. Kaczensky et al. 2004; Majić and Bath 2010), interactions and conflicts with bears (e.g. Dickman et al. 2014; Kaczensky et al. 2004), general attitudes (Majić and Bath 2010), knowledge, knowledge acquisition, and culture (Dickman et al. 2014; Glikman et al. 2012; Kaczensky et al. 2004), perceived benefits and disadvantages of bears (Carter et al. 2012; Kaczensky et al. 2004), and bear management (Dickman 2010; Majić and Bath 2010; Redpath et al. 2012). For all questions on perceptions we used a 5-point Likert scale (from strongly disagree to strongly agree), whereas for all other questions we either used multiple choice or yes/no answers (46 questions total; Supplementary Material Appendix S2). Questions that could not be answered by the respondent were noted as "don't know".

We randomly selected 30 villages of the over 400 villages scattered throughout the 7441 km^2 study area spanning the full range of biophysical and social conditions (see Dorresteijn et al. 2014 for a more detailed description). The average number of inhabitants per village was 584 (min–max cc. 30–1900) (INS 2011). We aimed to complete 7-10 questionnaires per village. Sampling was based on the availability of the encountered persons and on the inclusion of different socio-demographic groupings. People were asked on the street or in the local shop if they were interested in participating in the questionnaire. Our aim was to ensure a diversity of responses, and not to choose a specific range of locals, and therefore we did not actively control for age, gender, or profession. However, to ensure a range of responses, at the end of the questionnaire the respondent was asked if he knew somebody from the village with a different profile, for example a person working in the forest or a person that recently experienced conflicts with bears.

General patterns on how social drivers influenced people's perception of coexistence were analysed using hierarchical agglomerative cluster analysis (Wards clustering based on

Euclidean distances: agglomerative coefficient of 0.95; *hclust* function from *stats* package) and principal component analyses (PCA; *prcomp* function from *stats* package). First, we used a cluster analysis to identify groups of people who had similar perceptions of the importance of different social factors (questions based on a 5-point Likert scale). We characterized these groups based on their perceptions of coexistence, interactions and conflicts with bears, and socio-demographic profiles. Second, we used PCA to extract the main social drivers of coexistence and related these to the four groups previously obtained from the cluster analysis. We calculated four separate PCAs for each of the following themes: (i) attitudes towards bears (Questions 23, 24, 25, 26, 36, 42); (ii) cultural values and bear knowledge acquisition (Questions 13 to 22); (iii) benefits and disadvantages related to bears (Questions 28 to 35); and (iv) bear management (Questions 37 to 41; Fig S2-S5). The questions included in each PCA came from questionnaire subsections on the respective themes (Appendix S2), with the exception of the PCA on attitudes towards bears, which was based on questions from two subsections (Fig. S2). First, we included the questions from the subsection on people's feelings towards bears, but excluded question 27 because the majority of respondent found this question confusing. Second, we added two questions from the bear management subsection because they captured people's attitudes towards protection and hunting of bears. However, these questions were included in the bear management subsection of the questionnaire to follow a logical order of the questions for the respondent.

For each theme, we plotted the first two axes and overlayed them with the four groups from the cluster analysis. We chose to extract only the first two principal components from each PCA in order to make the results more easily comparable and because a visual inspection of the scree plots revealed that explained variances were rapidly levelling off for higher components. Twenty individuals missed one question, and their responses were replaced with imputed values (i.e. the average of the total sample pool). All questions that were answered with "don't know" were scored with a 3 (neutral opinion about a statement). All statistical analysis were implemented in the 'R' environment (R Core Team 2014).

Social drivers affecting perceptions, based on questionnaires

We obtained 252 responses to the questionnaire. The majority of respondents had a positive perception of coexistence (n = 194; 77%, Table S1). Of all the respondents, 80 (32%) respondents perceived human-bear coexistence to be worsening, while 33 (13%) respondents perceived coexistence to be improving (Table S1).

The cluster analysis was based on all questionnaires and revealed four distinct groups of respondents (Fig. S1), which differed in their perception of coexistence, interactions with bears, and socio-demographic factors (Table S1). The majority of people clustered in groups 1 and 2 and had a more positive perception of current and future human-bear coexistence compared to

groups 3 and 4. Respondents from group 1 had the fewest interactions with bears, and respondents from groups 3 and 4 most frequently experienced damage to crops and predation on livestock. The largest proportion of women was in group 1 and the largest proportion of men was in group 2. Respondents in group 4 were oldest on average.

The identified groups revealed that attitudes towards bears, culture and knowledge acquisition, perception of damages and threats, and opinion of management, may be important social drivers influencing people's perceptions of human-bear coexistence. The four groups of respondents were characterized by their position along the main gradients of the four themes (Fig. S1; full ordinations can be found in Fig. S2-S5). Overall patterns were more similar between groups 1 and 2, who had a more positive attitude towards bears and between groups 3 and 4, who held a more negative attitude (Fig. S1). Similarly, groups 1 and 2 perceived bears to be less harmful than groups 3 and 4, while in contrast different perceptions regarding the benefits provided by bears were not reflected in the grouping (Fig. S1). Also, responses on the influence of culture, knowledge acquisition, and management had relatively little influence on the grouping. However, group 3 acquired most knowledge through experience, and group 4 ascribed low cultural importance to bears (Fig. S1). Opinions on management most importantly were characterized by the desire to be more actively involved, which was especially high for group 2, whereas the overall satisfaction with bear management differed only slightly between the groups (Fig. S1).

Discussion and implications

Our methodological approach provided two different perspectives on the drivers of human-carnivore coexistence that are complementary in scope. While the interviews (see main text) provided in depth information on the factors influencing perceptions of coexistence from the rural people's perspective, the questionnaires revealed general patterns of important drivers within groups of people. The questionnaires showed that perceptions of coexistence were influenced negatively especially by negative attitudes, past negative interactions with bears, perceived risks of damage, and respondents' age, which is in line with the results from the interviews and previous studies (e.g. Carter et al. 2012; Kaczensky et al. 2004; Naughton-Treves et al. 2003).

Besides revealing broad patterns in the drivers of coexistence between groups, grouping people with similar perceptions may be beneficial for the design of more specific conservation programs targeted at different groups or societal concerns. For example, for people in group 3 and 4, education may be an important tool to address their perception of how harmful bears are (also see discussion in the main text on managing coexistence). Especially for people in group 3, education could be complemented with mitigation strategies to reduce conflict, which can be especially important since livestock predation rates of bears are related to local conditions

(Dorresteijn et al. 2014). In contrast, educational tools for people in group 1, which had a high proportion of women, could focus on reducing fear levels towards bears. This group also indicated to have few direct interactions with bears, and one option could be to create direct positive interactions with bears to reduce fear (also see discussion in the main text). Carnivore management through participatory processes could be especially interesting for people in group 2, because this group showed most interest to be involved in bear management.

Similarly to the emerging factors from the interviews, culture and experiential learning influenced the grouping, although with less strength than the other themes. The importance of considering cultural drivers in human-carnivore conflict research and management is increasingly recognised (e.g. Dickman et al. 2014; Lagendijk and Gusset 2008; Li et al. 2013), and understanding how cultural tolerance shapes people's perception of human-carnivore coexistence is an important issue for future research. Similarly to other regions in Europe (Glikman et al. 2012; Kaczensky et al. 2004), knowledge did not differ between the different groups and seemed of minor importance in shaping perceptions about bears. However, considering the importance of knowledge mediating people's attitudes towards carnivores found elsewhere (e.g. Ericsson and Heberlein 2003; Kellert et al. 1996; Williams et al. 2002), the lack of an effect of "knowledge" may be related to how we quantified it. Knowledge is difficult to quantify, and especially because many people drew on experiential knowledge, it is likely that our questionnaire did not adequately capture some key topics which were separately revealed in in-depth interviews (e.g. the difference between carnivorous and ant-eating bears).

In summary, while the questionnaires provided a useful additional angle of insight on human-bear coexistence, we considered that the more interesting nuances were captured better by in-depth interviews. Hence, we focused on these in the main manuscript.

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Table S1. Perception of current and future coexistence, socio-demographics, frequency of actual bear encounters and conflicts, and average knowledge score, of the four different groups derived from the cluster analysis based on the questionnaires. The number of people and the percentage in parentheses within a certain group are given.

	Group 1 (n = 84)	Group 2 (n = 87)	Group 3 (n = 50)	Group 4 (n = 31)
Current Coexistence				
Positive	70 (83)	82 (94)	24 (48)	18 (58)
Negative	14 (17)	4 (5)	25 (50)	13 (42)
Future Coexistence				
Better	9 (11)	20 (23)	2 (4)	2 (6)
No change	35 (42)	44 (51)	15 (30)	7 (23)
Worse	23 (27)	13 (15)	29 (58)	15 (48)
Gender				
Male (n = 181)	46 (55)	78 (90)	34 (68)	23 (74)
Female (n = 71)	38 (45)	8 (9)	16 (32)	8 (26)
Average age	47	46	47	62
Frequent bear observations	7 (8)	22 (25)	19 (38)	9 (29)
Frequent damage to crops, orchards and hives	6 (7)	5 (6)	21 (42)	6 (19)
Frequent attacks on livestock	1 (1)	2 (2)	8 (16)	2 (6)

Figure S1. The left panel shows the dendrogram and the four groups of people derived from hierarchical agglomerative cluster analysis. The other panels show the principal components analyses of the four different themes. The upper row shows the main gradients, whereas the lower four rows show the loadings for each group on the different PCAs. The legs of the spider diagrams indicate each person belonging to a given group and the circle indicates the standard deviation of the weighted average of each group.

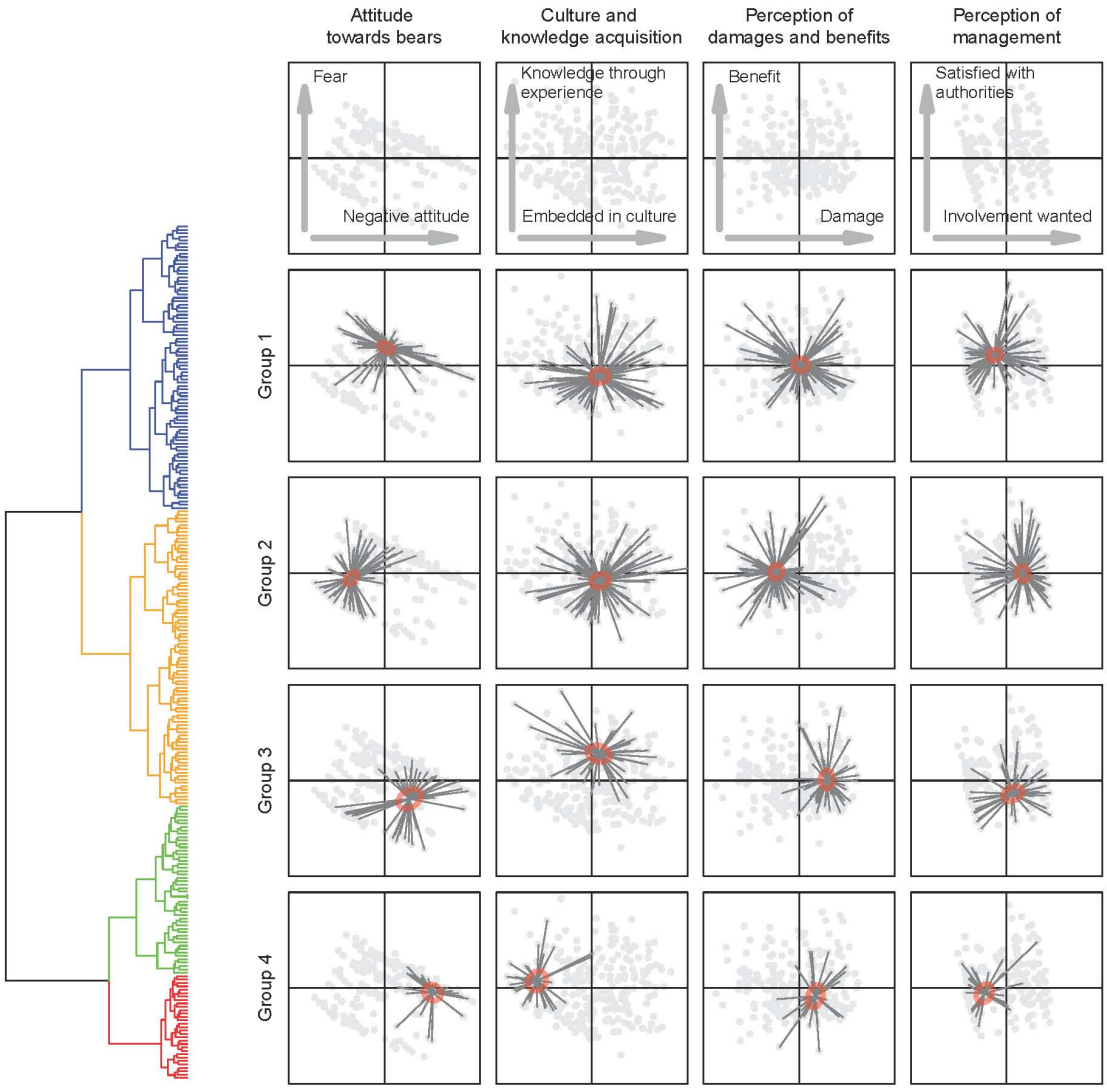

Figure S2. Principal Component Analyses of all questions reflecting a given participant's attitudes towards bears. The numbers reflect the four different groups derived from the hierarchical agglomerative cluster analysis. The "QX" indicates the question from the questionnaire in Appendix S1. The PCA was based on the following six questions: 23-26, 36, 42.

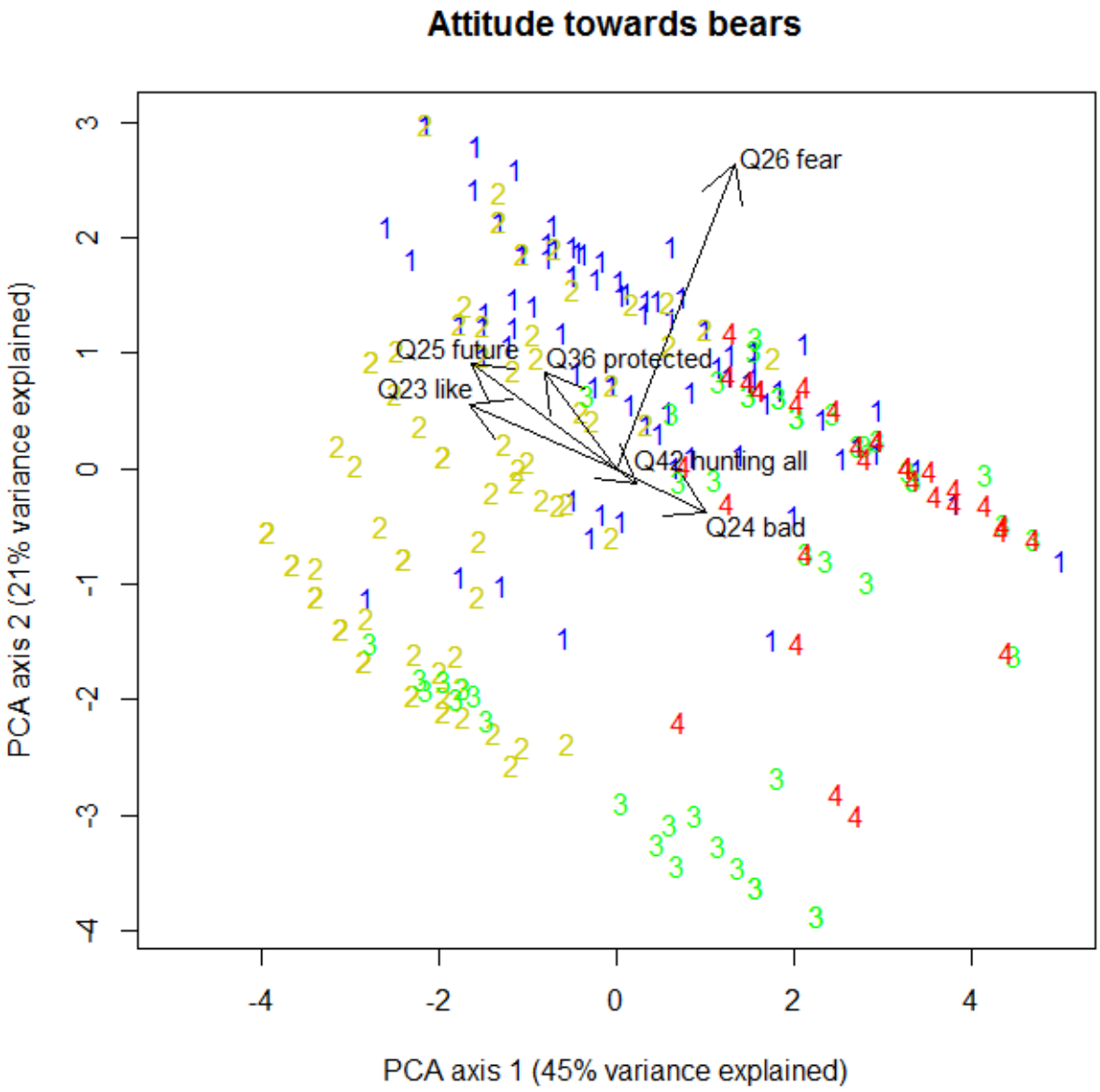

Figure S3. Principal Components Analysis of all questions reflecting a given participant's perception of cultural values of bears and knowledge acquisation about bears. The numbers reflect the four different groups derived from the hierarchical agglomerative cluster analysis. The "QX" indicates the question from the questionnaire in Appendix S1. The PCA was based on the following ten questions: 13-22.

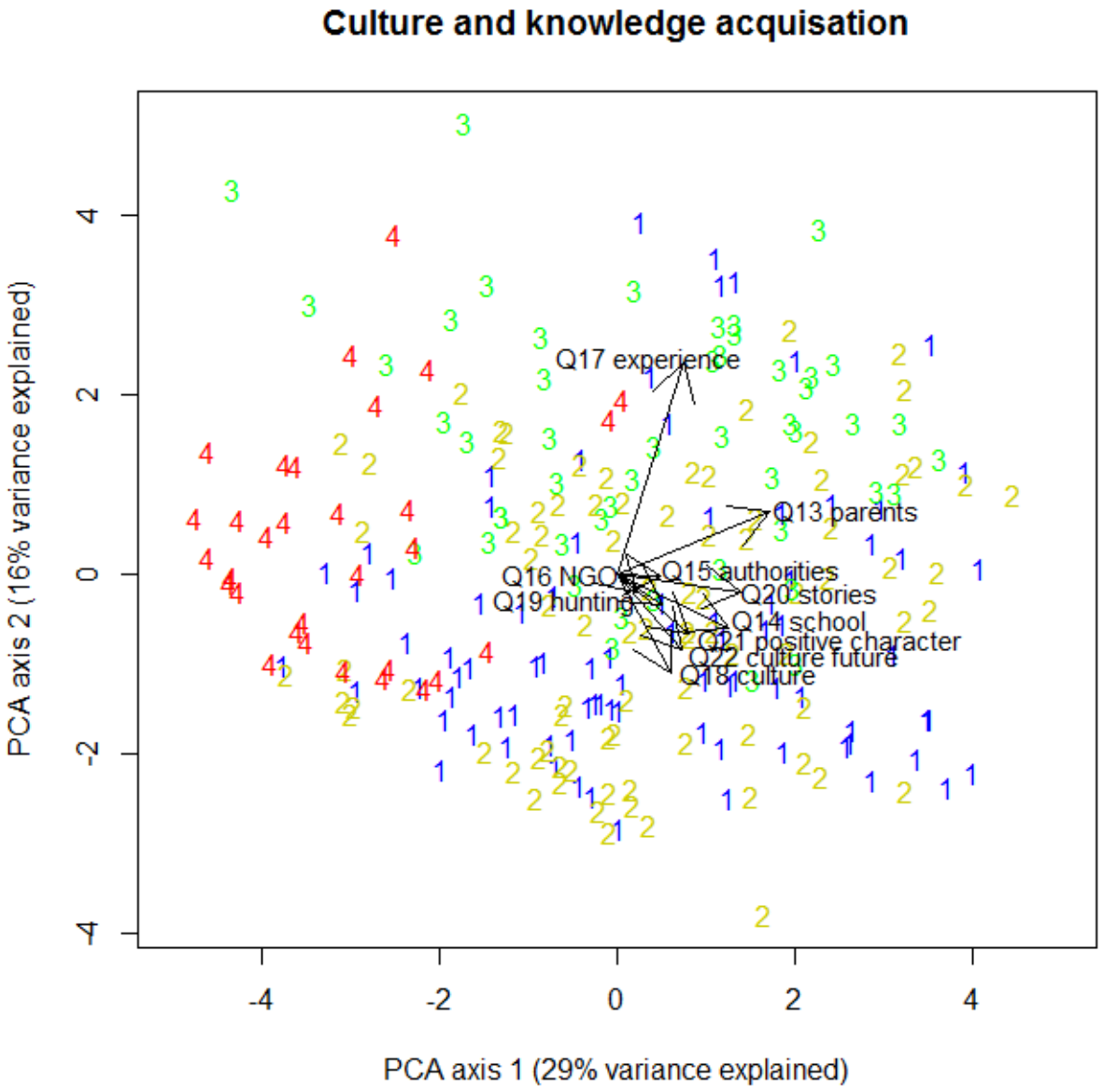

Figure S4. Principal Components Analysis of all questions reflecting a given participant's perception of bear-related benefits and disadvantages. The numbers reflect the four different groups derived from the hierarchical agglomerative cluster analysis. The "QX" indicates the question from the questionnaire in Appendix S1. The PCA was based on the following eight questions: 28-35.

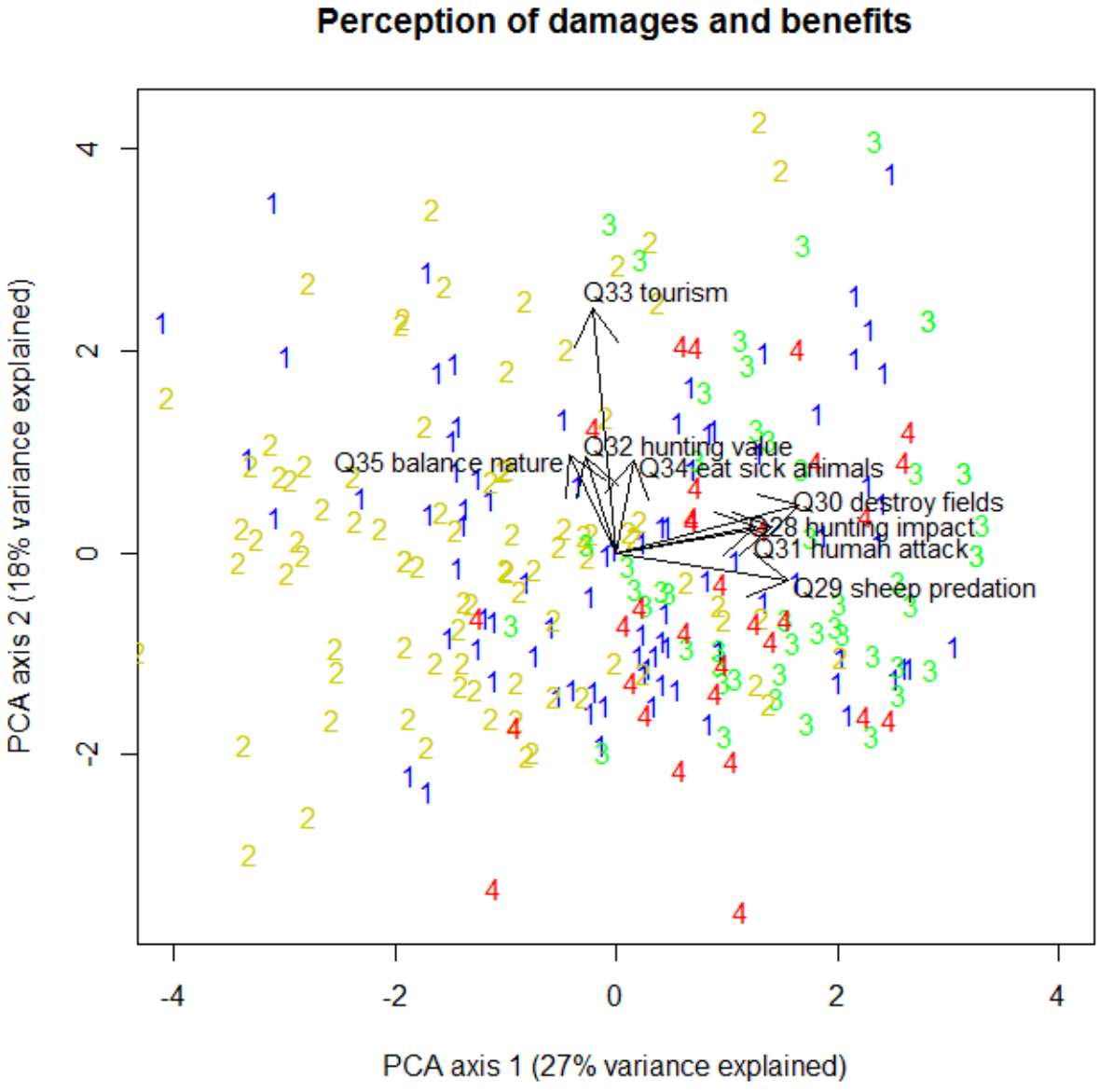

Figure S5. Principal Components Analysis of all questions reflecting a given participant's perception of current bear management. The numbers reflect the four different groups derived from the hierarchical agglomerative cluster analysis. The "QX" indicates the question from the questionnaire in Appendix S1. The PCA was based on the following five questions: 37-41.