An evaluation of the subjective categorization of hair quality pelt traits in Karakul lambs

S.J. Schoeman* and Jaenette R. Albertyn[1]
Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria, 0002 Republic of South Africa

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In an investigation of the subjective categorization of pelt traits in Karakul lambs it was demonstrated that the common practice of treating the categories of a trait as equally spaced intervals is invalid.

In 'n ondersoek na die subjektiewe kategorisering van pelseienskappe by Karakoellammers is aangetoon dat die algemene praktyk om die kategorieë van 'n eienskap as gelyk-gespasieerde intervalle te beskou, ongeldig is.

Keywords: Hair quality, Karakul lambs, ordinal scale, subjective scores.

* To whom correspondence should be addressed.
[1] Present address: P.O. Box 35, Maltahöhe, Namibia 9000.

Introduction

Since Karakul pelts are a fashion article, lambs must be evaluated subjectively by a trained judge, whether this be for the purpose of selecting breeding stock or determining the value of a pelt at an auction. Such ordinal scale measurements (Stevens, 1958) are often analysed by methods suitable for interval-scale or ratio-scale variables.

In 1982, the Karakul Breeder's Association of southern Africa (KBA) published detailed specifications for the scoring of all pelt characteristics (KBA, 1982). Of these, hair quality is regarded from both an economical and a genetical point of view as the most important pelt trait (Nel, 1966; Van Niekerk *et al.*, 1968; Schoeman & Nel, 1969; Van Niekerk, 1972; Le Roux, 1979). It has an influence on the durability of pelt garments. Hair quality is a complex or composite trait and is composed of contributing traits like lustre, texture and hair thickness. Of these, only the lustre of the pelt, the thickness of the hair and the overall quality score of the pelt will be discussed in this paper. The same phenomenon, however, applies to all other pelt traits, e.g. pattern score and pelt thickness.

Material and Methods

Data description

The data were obtained from 5 187 single-born black Karakul lambs in the Lovedale Karakul stud in Namibia. The lambs were subjectively evaluated by the breeder for all traits at approximately one day of age according to the procedure laid down by the Karakul Breeder's Association (KBA, 1982).

The lustre of a black Karakul pelt is measured as a mixture of a nominal and ordinal scale. Four words are used in the description of lustre: radiant, normal, dull and metallic. The latter two words refer to aberrant types and describe pelt characteristics which do not stand in any relationship to one another. However, radiant is considered superior to normal, which is considered superior to dull/metallic. A seven-point scale is defined: radiant, normal–radiant, normal (normal–dull, normal–metallic) and (dull, metallic). The brackets define a five-point ordinal scale. Without the brackets one has a mixed ordinal/nominal scale. No lambs were recorded in the category 'metallic' in the data set of this study. Since only 3 of the 5 187 lambs in the data set were classified as 'dull', this class was pooled with the normal–dull and normal–metallic class.

The thickness of the hair of a pelt (taken from a specified part of a pelt) could be measured with an appropriate instrument, but the KBA defines an ordinal scale which classifies the possible thickness (in microns) into one of five intervals, as displayed in Table 1. Note that the centre interval is almost twice as wide as the second and third intervals. Therefore, the practice of replacing the category labels 'thin', 'medium–thin', etc. with '1', '2', etc. and analysing the resulting data is obviously invalid. Randall (1993) has suggested that the category labels might be replaced by the group medians in a case like this, but such a practice would have to be preceded by an analysis to determine whether judges are scoring hair thickness in correspondence with the specified underlying scale.

The third trait investigated in this study is an overall numerical quality assessment. This nine-point ordinal scale (KBA, 1982) is effectively a six-point scale for the present data set, since the scores 1, 2 and 3 (corresponding to very poor quality) were never assigned.

Table 1 The KBA ordinal scale for hair thickness

KBA scale	Thin	Medium—thin	Medium	Medium—thick	Thick
Underlying scale	to 27	27—30	30—35	35—38	38 plus
Width of interval		3	5	3	

Table 2 The frequency table for lustre

KBA scale	Dull	(Normal—Dull	Normal—Metallic)	Normal	Normal—Radiant	Radiant	Total
Frequency	3	27 + 64 = 91		1 448	2 512	1 133	5 187
Pooled	(	94	)	1 448	2 512	1 133	5 187

Table 3 The frequency table for hair thickness

KBA scale	Thin	Medium—thin	Medium	Medium—thick	Thick	Total
Frequency	89	757	3 851	445	45	5 187

Table 4 The frequency table for quality score

KBA scale	4	5	6	7	8	9	Total
Frequency	16	108	1 598	2 516	881	68	5 187

Statistical procedure

The data were analysed by the methods described by Randall (1993). The computer program used was written in the Interactive Matrix Language (PROC IML) of the SAS Institute (1989) by Randall (1993). In the first analysis performed, the total frequency of each point of a scale was determined. These frequencies are displayed in Tables 2, 3 and 4. A model assuming an underlying normally-distributed continuous variable was fitted to these tables, making various assumptions about the cut-off points on the underlying scale. The deviance was calculated as a measure of the goodness of fit of a model, and the differential deviance (the difference between the deviances of two models, one nested within the other) was used to decide on the appropriateness of the simpler model relative to the more general model.

Results and Discussion

Lustre

Under the assumption that the ordinal-scale measurement 'lustre' is an ordered categorization of an underlying normally-distributed variable, the number of measurements in a group will define the group boundaries of that group. Thus (see Figure 1), with 94 of the 5 187 observations in the lowest group, the cut-off point separating this group from the next group is at ϕ^{-1} (94/5 187) = –2.094174, in which ϕ is the cumulative distribution function of the standard normal distribution. Similarly, the cut-off between the normal and normal–radiant categories is at ϕ^{-1} [(94 + 1 448)/5 187] = –0.532235. Now fitting a model which specifies equally spaced cut-off points, the result is an estimate of –1.954 ± 0.0284 for the first cut-off point and 1.377 ± 0.0178 for the common increment. This model is associated with a differential deviance of 27.8892 with 1 degree of freedom (df), which indicates that it fits the data very poorly. The implication is that one cannot simply code the first category with the symbol '1', the second '2', etc. and then follow this coding with an analysis of these codes (which are equally spaced) as though the coding is equivalent to the original measurement ('normal', 'radiant', etc.). A superior method of scaling (but not necessarily a superior method of analysis) would be to replace the name codes with group medians. Thus ϕ^{-1} [½(94)/5 187] = 2.6631 and ϕ^{-1}{ [94 + ½(1 448)]/5 187} = –1.00395, etc. (For convenience, one might add 5 to each of these values.) Note, however, that the assignment of these scores is just as arbitrary as the assignment of equally spaced scores, because of the arbitrary assumption of an underlying normally-distributed variable.

Hair thickness

The model fitted to the overall total frequencies is displayed in Figure 2. If judges assign hair thickness scores in accordance with the KBA scale, then the observed category widths will be in the proportions 3 : 5 : 3. The observed widths, 1.135, 2.296 and 1.065 could be in the proportions 1 : x : 1, but then x = 2.1 instead of 5/3 = 1.67. Thus, it would seem that (relative to the other categories), the 'medium' category is assigned

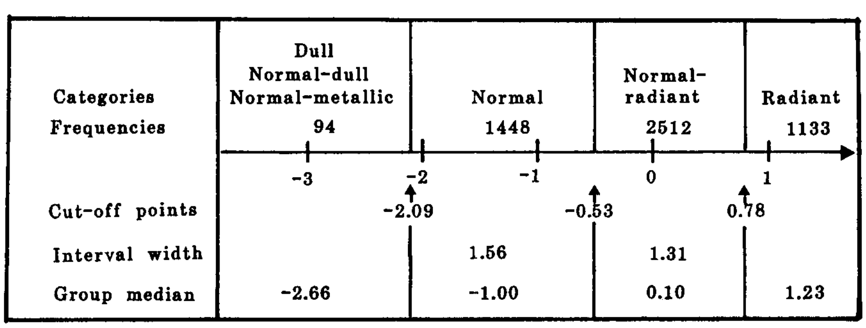

Figure 1 Lustre as a categorization of an underlying normally-distributed variable.

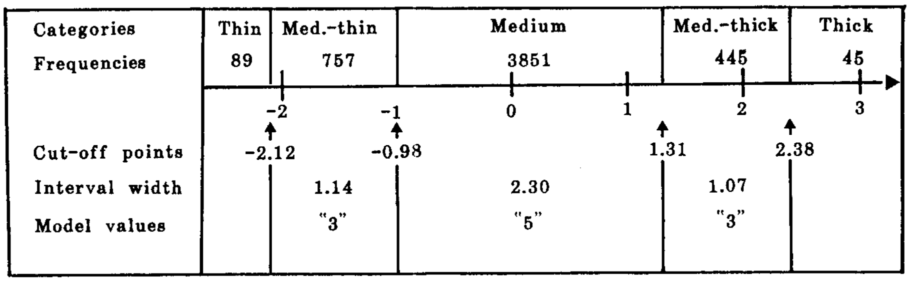

Figure 2 Hair thickness as a categorization of an underlying normally-distributed variable.

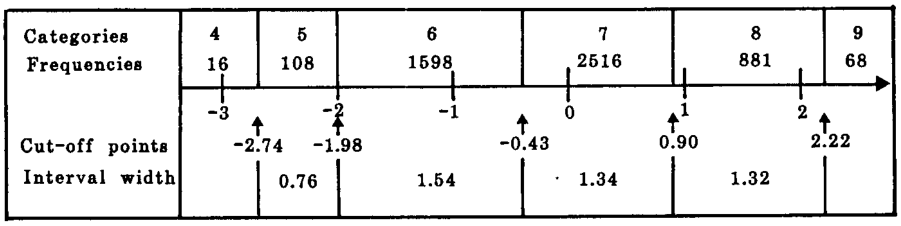

Figure 3 Quality score as a categorization of an underlying normally-distributed variable.

more often than required by the KBA scale. Fitting a model assuming the KBA spacing, yields a differential deviance of 42.8899 with 2 df which is strong evidence in contradiction of the assumed model.

As a matter of interest, the model assuming equally spaced cut-off points was also fitted, yielding a differential deviance of 506.3243, based on 2 df. This value represents massive evidence in contradiction of the assumption. There can be no doubt that the practice of analysing equally spaced scores for the categories of an ordinal scale is invalid in this case.

A criticism of the foregoing analyses is that they are based on the overall frequencies. If these frequencies arise as totals over a mixture of distributions, then any model specifying a single (common) distribution will fail to fit. To investigate the possibility of being misled by this fact, lambs were classified according to month of birth (January 1966 being arbitrarily labelled '1', so that a lamb born in February 1968 would be classified as being born in month '26'). Lambs were also classified according to the age of the ewe in the month of the birth. These two factors were chosen for the classification because it is known to affect these traits (Nel, 1966; Greeff *et al.*, 1991; Albertyn *et al.*, 1993). Only those groups in the cross-classification with at least 5 lambs were used in this analysis, a total of 2492 lambs in 287 groups. The same three models were fitted as before in regard to the cut-off points, but the models allowed for a different mean for each of the 287 groups. The differential deviances were 16.3592 with 2 df in the case of KBA spacing and 239.0807 with 2 df in the case of equi-distant spacing. Our conclusion was that the large differential deviance (475.9086 with 286 df) associated with the model allowing for varying group means confirmed the suspicion of a mixture of distributions, but that the conclusions based on the overall frequencies were not materially modified by a more careful analysis. (This phenomenon is to be ascribed to our use of differential deviances. Both the full model and the reduced model used, assumed a single distribution; the only difference between the models related to the nature of the cut-off points. Therefore, any inappropriateness in the specification of the cut-off points would be a major factor in determining the value of the differential deviance.)

Quality

Fitting a model allowing arbitrary spacings to the overall frequencies in the case of quality scores, yields the results displayed in Figure 3. Instead of being constant, the spacings (lengths of category intervals) vary between 0.76 and 1.54. Fitting a model assuming equally spaced cut-off points, yields a differential deviance of 58.7362, based on 3 df, which indicates strong evidence in contradiction of the assumption.

Conclusions

In conclusion, it was clear that the breeder assigned some categories of lustre, hair thickness and quality score more often, and some less often than required by the KBA scale, which are assumed to be underlying normally-distributed continuous variables. The common practice of treating these categories as equally spaced intervals, is demonstrated to be invalid. Possible changes in the scoring system of these traits should be considered. The possible use of a more simplified procedure of scoring Karakul lambs, should be investigated. Similar investigations into other pelt traits, such as pattern score, should also be undertaken.

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References

ALBERTYN, J.R., SCHOEMAN, S.J. & GROENEVELD, H.T., 1993. Factors influencing the quality of Karakul pelts, with emphasis on discrete characteristics. *S. Afr. J. Anim. Sci.* (submitted).

GREEFF, J.C., FAURE, A.S., MINNAAR, G.J. & SCHOEMAN, S.J., 1991. Non-genetic factors affecting pelt traits in Karakul sheep. *S. Afr. J. Anim. Sci.* 21, 173.

KARAKUL BREEDEER'S ASSOCIATION OF SOUTHERN AFRICA (KBA), 1982. Beskrywing van Karakoellammers en die beoordeling van foto's. *Karakul* 24, 13.

LE ROUX, P.J., 1979. The role of the State regarding extension and Karakul research with special reference to hair quality. Symposium on hair quality of Swakara pelts. 24—26 October, 1979, Windhoek.

NEL, J.A., 1966. Genetic studies in Karakul sheep. D.Sc.(Agric) thesis, Univ. of Stellenbosch.

RANDALL, J.H., 1993. Some tools for the analysis of ordinal data. *S. Afr. J. Anim. Sci.*, 23, 51.

SAS INSTITUTE INC., 1989. SAS/IML^R Software: Usage and reference, Version 6 (1st edn.). Cary, NC: SAS Institute Inc., 1989, 501 pp.

SCHOEMAN, S.J. & NEL, J.A., 1969. Die relatiewe ekonomiese belangrikheid van Karakoelpelseienskappe. *Agroanimalia* 1, 189.

STEVENS, S.S., 1958. Measurement and man. *Science* 127, 383.

VAN NIEKERK, A.J.A., 1972. 'n Studie van teeltprobleme by Karakoelskape met spesiale verwysing na die Niemöllerkudde. D.Sc.(Agric.)-proefskrif, Univ. O.V.S., Bloemfontein.

VAN NIEKERK, A.J.A., SCHOEMAN, S.J. & NEL, J.A., 1968. Oorerflikhede van en genetiese korrelasies tussen Karakoelpelseienskappe. *Handl. S.-Afr. Ver. Diereprod.* 7, 161.