SHORT COMMUNICATION

# TESTING FOR UNI-DIMENSIONAL SCALING OF STIMULI USED IN PREFERENCE EXPERIMENTS

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**Abstract**

*Animal Welfare 1994, 3*: 45-49

*Many animal preference experiments involve test stimuli that have been chosen by the experimenter to represent different strengths of a single attribute. It is assumed that the animals also scale the test stimuli along a single dimension. This paper shows how it is possible to use the 'Unfolding Technique' developed by Coombs (1964) to check the validity of this assumption. A simple experiment is described which used Coombs' technique to verify that three visual test stimuli were ranked by laboratory rats along a single dimension. These stimuli were subsequently used in an experiment to see how different housing conditions changed rats' preferences for visual complexity.*

**Keywords**: *animal welfare, experimental design, preference experiments, scaling criterion*

## Introduction

In a recent paper, Blom *et al* (1993) used multiple choice tests to assess the preference of mice for various types of bedding material. The four test stimuli were chosen to lie at points along a dimension representing the particle size of the sawdust used (ie small, medium, large and extra large particles). The results were however '*difficult to interpret because they seem inconsistent. This may be due to preferences being related to some characteristic of the bedding material other than particle size*' (Blom *et al* 1993, p 84-85). Thus although the types of bedding material were chosen to differ only in particle size, the assumption that mice would also differentiate them along a single 'particle size' dimension appears not to be valid. The present paper briefly describes a technique that can be used to check such assumptions.

## Methods

### *The Unfolding Technique*

Coombs (1964, Ch 5) developed what he called 'the unfolding technique in one dimension'. This procedure may be used both to test the hypothesis that an unidimensional attribute underlies the observed behaviour, and to construct an unidimensional scale of the test stimuli. The technique assumes that each individual and each test stimulus may be represented by a point on a common dimension (called a 'J scale'). An individual's preference ordering of the test stimuli from the most to the least preferred, corresponds to the absolute distances of the stimulus points to the point representing the individual (called the 'ideal point'); the nearest stimulus being the most preferred. The individual's preference order of the test stimuli is called an 'I scale' and it may be thought of as the J scale folded about the ideal point with only the rank order of the stimuli given in order of increasing distance from the ideal point (see Figure 1a).

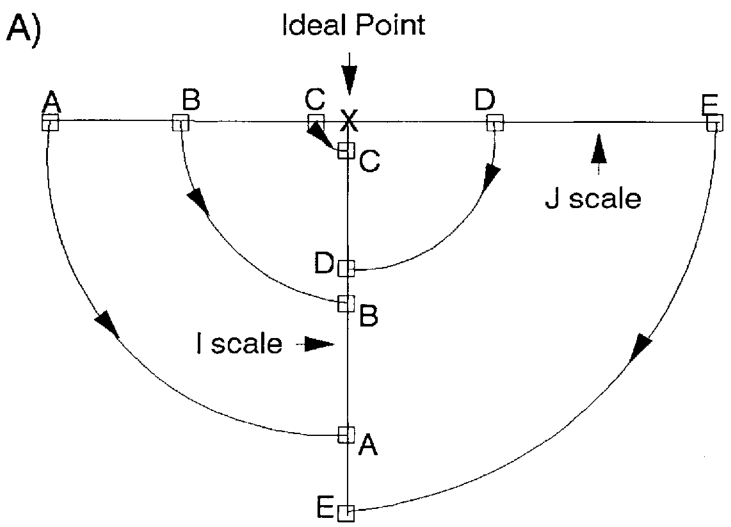


Figure 1a Diagram showing how an I scale preference order for five stimuli C>D>B>A>E (where > represents 'preferred over') was obtained by folding a J scale, containing the stimuli in the order A-B-C-D-E, about the subject's ideal point (X).

*(after Coombs 1964)*

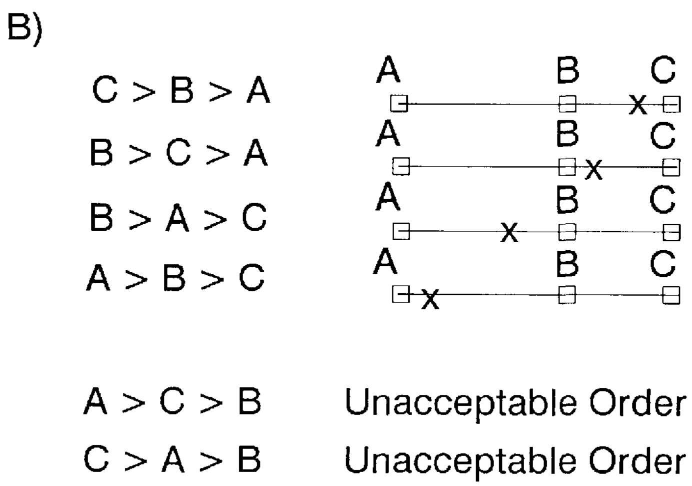


Figure 1b The six possible preference orders for three stimuli showing how four of them can be mapped onto a single dimension by placement of the ideal point at different positions. The other two preference orders are unacceptable since it is impossible to obtain a linear J scale from them.

Using the unfolding technique to obtain metric information of the spacing of test stimuli along the underlying dimension can be complex (see Coombs 1964, Ch 5), requires the use of at least four stimuli and additionally assumes that the J scale distances obtained under one experimental procedure will not, from the subject's viewpoint, change if the experimental procedure is changed. It is however far simpler to use the technique just to check that an unidimensional attribute underlies the observed behaviour.

An example of how Coombs' ideas can be used in practice is the following pilot experiment conducted to check that laboratory rats scaled three visual stimuli, that differed in complexity, along a single dimension. These stimuli were subsequently used in experiments to see how varying periods under sensory-deprived or sensory-enriched environments changed the rats' preferences for complex visual stimuli (Inglis & Freeman 1976).

The three stimuli were A) plain, B) striped and C) chequer-board patterns, and it was assumed that they would be ordered A-B-C along a dimension of increasing complexity. There are six possible preference orders of three stimuli, but only four of these are possible if the stimuli all lie on a single dimension. These four orders can be produced by different individuals' ideal points being at different places on the dimension, or by a single individual's ideal point moving along the dimension (see Figure 1b). The other two preference orders are 'unacceptable' since it is impossible to locate an animal's ideal point along a single dimension using them. Hence if the animals do order the three stimuli along a single dimension there should be a significant lack of unacceptable preference orders in the data.

*Subjects*

The subjects were nine female Lister hooded rats approximately five months old. They were all experimentally naïve at the time of testing. Since weaning they had been housed in laboratory cages measuring 50cm x 40cm x 20cm high. There were three animals per cage until the time of the experiment when they were housed singly. They were kept under a 12h on / 12h off light regime and tested during the light phase of the cycle.

*Procedure*

The test apparatus was a three arm radial maze constructed of perspex; each arm was 50cm long, 30cm high and 15cm wide. The stimulus patterns were mounted behind the perspex walls; one arm contained stimulus A, another stimulus B and the third stimulus C. A photocell assembly connected by a solid state processor to a three channel printout timer automatically recorded the time spent in each arm. The maze was housed in a soundproof room illuminated by a single 40W light suspended above the centre of the apparatus. The printout timer was in a separate room so that its operation was not audible to the rats.

Each subject was given one 10 min trial per day on three consecutive days (Trials 1, 2 and 3). The rat was simply placed in the central portion of the maze and left for 10 minutes. Between trials the arms of the maze were randomly switched in position. After each trial the animal was replaced in its home cage and the maze cleaned. The total time the rat had spent in each arm was then noted. The preference orders were determined by ranking the scores for the time spent with each stimulus.

Note that in this context the fact that more time was spent in the presence of one stimulus than another does not necessarily mean that the rat preferred the former in the sense that it was less stressed in the presence of that stimulus. Exploration can be stressful and it is not known whether the time spent in an arm represents inspective exploration (ie a forced response *to* an environmental change) or inquisitive exploration (ie a free response *for* an environmental change: Berlyne 1960), or a mixture of both. This does not however alter the validity of using the time measure to check that the rats rank the three stimuli along a single dimension.

## Results

As two of the six possible preference orders are unacceptable, the probability, assuming that there is no preference between stimuli, that an animal will show an unacceptable preference order on a given Trial is 0.33. No unacceptable preference orders were shown on Trials 1 and 2 whilst one of the nine subjects showed an unacceptable preference order on trial 3 (see Table 1). The binomial test (Siegel 1956) can be used to calculate the probability of each of these outcomes. The probability that none of the nine rats would by chance show an unacceptable preference order is 0.023, whilst the probability that one of the nine would is 0.101 (see Table 1). The average probability per trial is 0.049. It can therefore be concluded that there was a significant tendency for the rats not to produce unacceptable preference orders; a result congruent with the proposition that they rank the test stimuli A-B-C along a single dimension. The stimuli were therefore used in subsequent experiments designed to look at the effects of housing conditions on shifts in preference along this dimension (Inglis & Freeman 1976).

**Table 1 Preference orders obtained for each subject over the three trials (> means preferred over, * marks an unacceptable preference order, *P* = probability that the outcome of that trial could have occurred by chance).**

| Subject | Trial 1 | Trial 2 | Trial 3 |
|---|---|---|---|
| *1* | C>B>A | C>B>A | C>B>A |
| *2* | C>B>A | B>C>A | B>C>A |
| *3* | C>B>A | B>C>A | B>C>A |
| *4* | C>B>A | A>B>C | B>A>C |
| *5* | A>B>C | B>C>A | B>C>A |
| *6* | B>C>A | B>A>C | B>C>A |
| *7* | C>B>A | A>B>C | A>C>B* |
| *8* | A>B>C | B>C>A | B>C>A |
| *9* | A>B>C | B>C>A | B>C>A |
| *P* | 0.023 | 0.023 | 0.101 |

## Conclusions

I hope this simple example has illustrated how the techniques pioneered by Coombs (1964) can be of use in checking the assumption that underlies many preference experiments. It should be remembered that validation of the unidimensional assumption does not automatically reveal the relevant stimulus attribute. It is possible that several attributes have been combined by the subjects into a single psychological dimension. However, where more than one attribute is involved then it is most likely that the data will not satisfy the unidimensional criterion. The unfolding methodology can be extended to multidimensional scaling where a set of stimuli are thought to differ along two or more separate sensory dimensions (see Coombs 1964).

## Acknowledgements

I am grateful to Steve Langton and Andy Hart for their constructive comments on an earlier draft of this paper.

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