On the direct estimation of mood change

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A scaling model is described that allows mood variation to be assessed from direct estimates of change, for given dimensions of mood. Possible applications are, for instance, psychopharmacological experiments where a natural reference state may not exist or lengthy series of observations where the invariance of a "standard state" is difficult to control. An experiment was conducted to test the interdimensional consistency of scale values obtained by the proposed model for alcohol-induced changes in tension state and euphoria.

The problems of measurement involved in the mapping of "mood" are rather more complex than the common use of mood-adjective checklists might suggest, from the point of view of qualitative as well as quantitative variation, and some of the traditional assumptions underlying their use have been criticized, for example, with respect to best response scale format and appropriate psychometric model (Sjöberg, Svensson, & Persson, 1979). The aim of the present paper is to propose a model that yields data more sensitive to time-dependent variation for predetermined dimensions of mood than do the usual estimates produced on 4- or 5-point scales anchored at a common standard state, such as "normal" or "as usual."

Increased precision is frequently desirable, for instance in psychopharmacological experiments in which mood is studied as a function of treatments and elapsed time in a repeated measures design, and the advantages of magnitude estimation in this respect were clearly demonstrated in some of the early studies on the subjective effects of alcohol (Ekman, Frankenhaeuser, Goldberg, Bjerver, Järpe, & Myrsten, 1963; Ekman, Frankenhaeuser, Goldberg, Hagdahl, & Myrsten, 1964; Myrsten, 1971). The invariance of the standard state is, however, often difficult to control. Sometimes a natural reference state may simply not exist, for instance due to pharmacological action, or it may be hard to define for other reasons. Problems of this kind could be avoided if the subjects were allowed to communicate their mood *changes* directly instead of making their estimates relative to a fixed standard on repeated occasions.

MODEL

If mood variation on a given dimension is studied at

The author is indebted to Hannes Eisler, at the University of Stockholm, for his helpful advice on Equation 3, and to Ann-Mari Stenhäll, who conducted the experiment while a student at Åbo Akademi. Financial support was provided by the Finnish Foundation for Alcohol Studies, and the manuscript was completed in its present form while the author was a Fulbright Research Scholar at Florida State University, Tallahassee. The author's mailing address is: Department of Psychology, Åbo Akademi, Vårdbergsgatan 1, SF-20700 Åbo 70, Finland.

n points in time, to a fixed common standard, then ordinary magnitude estimation yields the time vector

$$R_1/R_s \quad R_2/R_s \quad \cdots \quad R_n/R_s, \quad (1)$$

At each point in time t ($t = 1, 2, \dots, n$) the subject is instructed to estimate his current state relative to the fixed standard state, R_s , which has usually been assigned a number such as 10 or 100. The components of the time vector are the scale values.

However, utilizing the subjective state of the subject at the beginning of experimental treatment, that is, the baseline state, as his first standard, R_0 , his first estimate, R_1 , may as well be defined relative to R_0 as to any arbitrary R_s . Thus, assigning to R_0 the value 100, the first estimate ($t=1$) will assume the form of a simple percentage: $R_1/100$. At the time of the next estimation ($t=2$), the subject is asked to consider R_1 his current standard, which is again assigned the value 100: the resulting estimate R_2/R_1 will again be expressed as a percentage. Updating the standard successively and resetting it at 100 every time, a time vector will be obtained, the components of which indicate *percentage changes*

$$R_1/R_0 \quad R_2/R_1 \quad R_3/R_2 \quad \cdots \quad R_n/R_{n-1}. \quad (2)$$

These data may be of immediate interest, for instance in trend or profile analyses. It is, however, also possible to transform the data into progressive change relative to a common standard, for example, R_0 . Assuming that the requirements for ratio scale data are met, the elements can be multiplied, yielding the time vector

$$\begin{aligned} \frac{R_1}{R_0} \cdot \frac{R_2}{R_1} \cdot \frac{R_3}{R_2} &= \frac{R_3}{R_0} & \frac{R_3}{R_2} \cdot \frac{R_2}{R_1} \cdot \frac{R_1}{R_0} &= \frac{R_3}{R_0} \\ \cdots \frac{R_n}{R_{n-1}} \cdot \frac{R_{n-1}}{R_0} &= \frac{R_n}{R_0} \cdot \frac{R_{n-1}}{R_{n-2}} \cdots \frac{R_1}{R_0} &= \frac{R_n}{R_0}, \end{aligned} \quad (3)$$

where R_0 can be regarded as unity, or a scale constant which can be omitted in denoting the scale values.

EXPERIMENT

Method

Blood alcohol levels. Blood samples were taken from the tip of

the index finger into 0.25-ml capillaries at 90, 150, and 285 min after the beginning of intake. The observed blood alcohol levels were 0.776 ± 0.052 , 0.709 ± 0.054 , and 0.276 ± 0.040 g/liter (mean $\pm$ standard errors).

Results

Manipulation Checks

Analysis of variance was used to evaluate the effects of the alcohol treatment and the order of treatments on mood. The data were the scale values for the *tense* and *elated* estimates made at 90 min after the beginning of intake, when the subjective effects of intoxication were assumed to be maximal and complete sets of data were available. The scale values had been transformed according to Equation 3, so that all were expressed in terms of change from baseline. Significantly reduced tension [$F(1,36) = 14.47$, $p < .001$] and increased elation [$F(1,36) = 11.74$, $p < .01$] were observed following alcohol treatment; both mood variables remained unaffected by the order in which the treatments had been administered. The mean *tense* and *elated* estimates observed

under alcohol and control conditions are shown in Figure 1 as functions of time for the duration of the experiment.

Interdimensional Consistency

All estimates of change were first expressed in terms of a common baseline according to Equation 3. As the estimates were unaffected by treatment order, the data were pooled within alcohol and control conditions regardless of the order in which the treatments had been administered. The relation between the calculated scale values for *tense* and *relaxed* is shown in Figure 2. The plot suggests a reciprocal function, as predicted.

For both pairs of mood dimensions, correlations were calculated: (1) for the combined data from both the alcohol condition and the control condition, and (2) for alcohol-induced changes only, that is, from the alcohol condition alone. All correlations were statistically significant: For *tense* vs. *relaxed*, $r_{xy} = -0.62$ ($N = 236$, $p < .001$; alcohol condition only, $r_{xy} = -0.76$, $N = 118$, $p < .001$) and for *elated* vs. *depressed*, $r_{xy} = -0.24$ ($N = 236$, $p < .01$; alcohol condition only, $r_{xy} = -0.29$,

Figure 1. Mean scale values transformed to a common baseline for elation (left ordinate) and tension (right ordinate) as functions of time: with alcohol treatment (filled circles) and without (open circles). Two-tailed significance levels by *t* tests for paired data of the differences between alcohol and control conditions: * $p < .05$, ** $p < .01$ (means and standard errors).

Figure 2. Successive estimates of mood change transformed according to Equation 3 for tension and relaxation: with alcohol treatment (filled circles) and without (open circles).

$N = 118$, $p < .01$). The statistical significance of the observed correlations implies that the basic necessary condition for interdimensional consistency was met by both sets of scale values. Although only the estimates of tension versus relaxation resulted in a common variance large enough to suggest practical use. But since the weakness was apparent in only one of the pairs of dimensions studied, it can probably be attributed to the specific difficulties that might have been involved in the estimation of euphoria rather than to a failure of the scaling model.

DISCUSSION

These results are consistent with previous observations in natural drinking contexts with moderate social drinkers—that alcohol effects include transient euphoria and tension reduction (Freed, 1978; Lindman, 1982; Russell & Mehrabian, 1975). Why, then, was elation more difficult to estimate consistently than tension?

Several explanations could be considered. First, the polarity and dimensionality of mood have been the subjects of considerable controversy (Sjöberg et al., 1979), whereas the evidence for the assumed underlying reciprocal relationship has been obtained on stimulus dimensions that are unequivocally bipolar in terms of physical units of measurement, for example, darkness/lightness (Torgerson, 1960), softness/loudness (Eisler, 1962; Stevens & Guirao, 1962), and smoothness/roughness (Stevens & Harris, 1962). Of abstract concepts, apparently only the importance versus unimportance of political office has

been studied (Shinn, 1974). Although “depressed” was the most frequently generated antonym of “elated,” it can be argued that the assumed reciprocal relationship is more likely to hold for *tense* versus *relaxed*, since these adjectives are less equivocally opposites. Furthermore, consistent estimates of tension/relaxation could be easier to make because of the presence of physical cues, such as muscular tension. In the case of elation, cues might be quite subtle, or even nonexistent, and the influences of random factors correspondingly greater. Finally, when evaluating all of the present correlations, it should be noted that none of the subjects taking part in the experiment became either tense or depressed to any extent comparable to the alcohol-induced increases in elation and relaxation. Hence, compared with conditions in which subjects would experience the full range of variation for all four scales, the correlations may well be attenuated through the present restrictions in range. Although an experimental test cannot be justified on ethical grounds, results consistent with this argument were incidentally observed by Lindman (1982). In an experimental study of mood and drinking in social and solitary contexts, a short series of mood estimates ($n = 3$) indicated a scaling consistency of $r = .92$ ($p < .001$) for *tense* versus *relaxed* when the comparison included both an aversive condition—solitary drinking in impersonal surroundings—and a pleasure-inducing condition—social drinking in a natural drinking context.

The slight curvature that is evident in the data (Figure 2) may have contributed to lower correlations. Similar curvilinearities were previously observed by Torgerson (1960), Eisler (1962), and Shinn (1974), and it has been shown that curvature can be reduced by the application of a correcting factor (Eisler, 1962; Shinn, 1974). Easier judgment tasks and an open definition of the standard stimulus have been proposed as means to reduce curvature (Shinn, 1974). It could be argued that the reference point at 200% in the present graphical ratio estimation procedure may have introduced boundedness into the response scale, and possibly curvature (cf. Montgomery, 1975). The proposed scaling model is, of course, adaptable to any form of data based on ratio estimation of change, but the graphical method appears to be worth further development, mainly on grounds of expediency, since it was comparatively easy to teach and the subjects retained acceptable consistency even under moderate intoxication. Whether or not a linear relationship holds for these data as compared with numerical estimation data should be verified experimentally in future studies.

The most serious weakness associated with the application of Equation 3 is, however, that statistical error will accumulate towards the end of a series of reconstructed scale values. Estimates of the relative amounts of accumulated error can be calculated for different values of n , based on Hald (1952).

Denoting the terms of Equation 2 in a simpler form, the raw estimates may be written $x_1, x_2, \dots, x_n$. Assuming any errors to be uncorrelated and random as to direc-

tion and magnitude, and denoting by y the reconstructed scale value based on the n^{th} estimate produced by one subject, we have, generally,

$$y = f(x_1, x_2, \dots, x_n), \quad (4)$$

or, more precisely, from Equation 3

$$y = x_1 \times x_2 \times \dots \times x_n. \quad (5)$$

Equation 5 may be written

$$\ln y = \ln x_1 + \ln x_2 + \dots + \ln x_n. \quad (6)$$

Denoting by dy the estimated standard deviation at the n^{th} reconstructed scale value, we have, by partial logarithmic differentiation,

$dy =$

$$\sqrt{[(\partial y / \partial x_1) \delta x_1]^2 + [(\partial y / \partial x_2) \delta x_2]^2 + \dots + [(\partial y / \partial x_n) \delta x_n]^2} \quad (7)$$

and

$$dy/y = \sqrt{(\delta x_1/x_1)^2 + (\delta x_2/x_2)^2 + \dots + (\delta x_n/x_n)^2}. \quad (8)$$

The computational formula can hence be written simply

$$dy = y \sum_1^n (\delta x/x)^2. \quad (9)$$

An initial error of 5% will thus entail a relative error of 11.2% at the 5th reconstructed scale value and 16.6% at the 11th. However, assuming an initial error of 10%, the corresponding accumulated errors will be considerable: 22.4% and 33.2%. It is obvious that any successful application of Equation 3 for a lengthy series of observations will be heavily dependent on the reliability of each estimate, and steps should be taken to ensure this.

As with magnitude estimation in general, naive subjects may find the task odd and confusing. Thorough familiarization with the procedure and preexperimental training were reasonably successful in the present experiment, and would seem advisable in future applications of the proposed model. Experimental designs should also provide for checks of the internal consistency of any transformed scale values before statistical analysis is attempted. If a

number of mood dimensions are studied simultaneously, the same adjective could, for instance, be repeated twice. A comparison of the observed scale values would then entirely avoid the vexing complications involved in the definition of unequivocally bipolar dimensions of mood.

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(Manuscript received May 10, 1984.

revision accepted for publication December 28, 1984.)