DOALL: A BASIC program solving for adaptation level and n in Helson's reformulated Stevens' power law

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Helson (1964) stated that Stevens' (1960) power law,

$$\Psi = k(\phi - \phi_0)^n, \quad (1)$$

should incorporate the observer's adaptation level (AL). The resulting reformulated power law would then be

$$\Psi = AL(\phi)^n, \quad (2)$$

where phi (ϕ) is a series stimulus. Phi subscript zero (ϕ_0) in Equation 1 is the minimal observable stimulus value for each subject. Solving these equations for AL and n in Equation 2 and for n and k in Equation 1 for each stimulus value in a five-stimulus series is a very long and tedious task. DOALL reduces this task into a set of simple operations.

Description. DOALL is a BASIC language program designed to solve for Helson's (1964) AL, the variable "n" in Helson's reformulated Stevens' (1960) power law and the variables "n" and "k" in Stevens' power law. This program solves for these variables by utilizing the following $\log_{10}$ formulas:

$$\log \Psi = \log AL + n \log \phi \quad (3)$$

and

$$\log \Psi = \log k + n \log (\phi - \phi_0). \quad (4)$$

Helson's AL is calculated using Helson and Himelstein's (1955) short method for calculating ALs.

Input. It is necessary to have the mean judgment value for each stimulus. This value is the average judgment of five presentations of each series stimulus. The minimal observable stimulus, ϕ_0 , must be calculated for each subject using any of the basic psychophysical methods (Dember & Warm, 1979). When solving for the exponent "n" in Stevens' power law, it is assumed that one does not have this value except when one is using a previously calculated value (Dember & Warm, 1979, p. 93). Exponent values such as those listed in Dember and Warm (1979) have been calculated by Stevens (1960) and may not be applicable in situations other than those specified by Stevens. The calculation of the constant "k" in Equations 1 and 4 requires a known "n" value, which can be obtained from Dember and Warm (1979).

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LIST
DOALL 08:27 PM 06-Jan-81
1 GEORGE M. CARTER; 1980 RESEARCH
2 SOLVING FOR ADAPTATION-LEVELS ,
   HELSON'S REFORMULATED STEVENS' POWER
   LAW AND STEVENS' POWER LAW
5 NOTICE THAT COLONS(:) ARE USED TO
   SEPARATE COMMANDS IN ORDER TO LESSEN
   THE OVERALL PROGRAM LENGTH
6 NOTICE...IN ORDER TO AVOID IMAGINARY LOG
   ANSWERS, WHEN SOLVING FOR STEVENS N OR K
   INPUT A VALUE OF 1 WHEN ASKED FOR IN THE
   INPUT STATEMENTS
10 X1=-2:M1=0:M2=0:I1=0:E2=0:I=0
20 INPUT INPUT LOWEST STIMULUS SERIES VALUE(X
30 INPUT INPUT STIMULUS SERIES STEP INTERVAL(S
35 IF S=0 THEN 500
40 PRINT INPUT MINIMAL OBSERVABLE STIMULUS*
45 INPUT (phi sub zero) (U)
50 INPUT INPUT STEVENS EXPONENT (N) (W
60 INPUT INPUT STEVENS CONSTANT (K) (U
65 IF W=0 OR U=0 THEN 550
70 PRINT INPUT THE SUBJECTS MEAN JUDGEMENTS*
75 PRINT FOR EACH STIMULUS (ex. A,B,C,D,E)*
80 DIM J(5):MAT INPUT J(5):PRINT T=X
70 PRINT ADAPTATION LEVEL TABLE*
110 PRINT TAB(2);X*;TAB(12);J*;TAB(23);Y*;
   TAB(35);X*;TAB(43);X*;Y*;TAB(54);X*2*
130 FOR I=1 TO 5
140 Y=J(1)/J(1)-J(1)/J(1):A=X1:B=X1*Y:C=X1^2
150 PRINT TAB(10);J(I);TAB(20);Y;
   TAB(32);A;TAB(40);B;TAB(54);C
160 M1=M1+Y:M2=M2+A:I1=I1+B:I2=I2+C
170 X1=X1+1:I=T+S:NEXT I:M1=M1/5:PRINT
190 PRINT TAB(18);M*;*M1;TAB(33);E(X/Y)=*E1
200 PRINT TAB(28);M*;*M2;TAB(47);E(X^2)=*E2
210 R=(E1/10)/S:B=M1-[R*(X*(S*2))]:F=1/R
220 G=F*(B*F):PRINT L/A=*R:PRINT B=*B
230 PRINT A=*F:PRINT ADAPTATION-LEVEL=*G
235 PRINT PRINT HELSONS N;TAB(20);STEVENS N;
   TAB(40);STEVENS K;TAB(60);STEVENS K*
240 FOR I=1 TO 5
250 N=LOG10(J(I))-LOG10(G)/LOG10(X)
260 F=LOG10(J(I))-LOG10(U)/LOG10(X-U)
270 M=LOG10(J(I))-LOG10(X-U):K=10^M
280 PRINT HN*;I*;*N;TAB(20);SN*;I*;*F;
   TAB(40);K*;I*;*K;TAB(60);K*;I*;*M
290 X=X+S:NEXT I:PRINT
320 INPUT AGAIN?(YES=1:NO=2) (Z
330 IF Z=1 THEN 10 ELSE 9999
500 PRINT ERROR!!! GOTO 30
550 PRINT ERROR...SEE PROGRAM LIST (LINE 6)*
555 GOTO 320
9999 END

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Ready

Figure 1.

Output. The program yields (1) Helson's (1964) AL in the form used by Helson and Himelstein (1955), (2) the exponent n for Helson's reformulated Stevens' (1960) power law, and (3) the exponent n and the constant k for Stevens' nonreformulated power law. This k appears in the nonlog form for Equation 1 and in the log form for Equation 4.

Hardware. The program was developed on a DEC PDP-11/34 RSTS/E computer (Version 6B) using BASIC-PLUS language. The development system had 112K of core with two RX01 floppy drives, three RK03 disk drives, and one RP02 disk pack.

Availability. Requests for reprints and a copy of the program output should be sent to Henry G. Masters, Department of Psychology, Juniata College, Huntingdon, Pennsylvania 16652.

REFERENCES

- DEMBER, W. N., & WARM, J. S. *Psychology of perception* (2nd ed.). New York: Holt, Rinehart, & Winston, 1979.
- HELSON, H. *Adaptation-level theory*. New York: Harper & Row, 1964.
- HELSON, H., & HIMELSTEIN, P. A short method for calculating the adaptation-level for absolute and comparative rating judgments. *American Journal of Psychology*, 1955, **68**, 631-637.
- STEVENS, S. S. The psychophysics of sensory function. *American Scientist*, 1960, **48**, 226-254.

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