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RIDE QUALITY JUDGMENTS AS A FUNCTION OF ENVIRONMENTAL, PERSONALITY, AND RIDE SPECTRA CORRELATES

By

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INTRODUCTION

This is the final progress report to be submitted under National Aeronautics and Space Administration (NASA) Research Grant NSG-1225. This project on "Ride Quality Judgments as a Function of Environmental, Personality, and Ride Spectra Correlates" has been conducted for the Acoustics and Noise Reduction Division of the NASA Langley Research Center, Hampton, Virginia under the direction of Dr. Glynn D. Coates (Associate Professor of Psychology), principal investigator, of Old Dominion University, Norfolk, Virginia. This report covers work completed during the grant period of 1 August 1975 through 28 February 1977.

Numerous investigations have been conducted in an attempt to evaluate the effects of various physical parameters on subjective judgments of ride quality both in the laboratory and in the field. While the majority of these investigations have concentrated their attention on the vibratory parameters (cf., Guignard and King, 1972; Jacobson, 1972), others have attempted to study the interaction of these vibratory variables with other physical parameters such as noise levels (e.g., Dempsey, Leatherwood, and Drezek, 1976). Data collected in these studies in combination with data collected using the NASA-Langley Research Center Passenger Ride Quality Apparatus (PRQA) has led to the development of a Passenger Ride Quality Model that permits prediction of ride quality judgments over a wide range of vibratory frequencies and accelerations (cf., Dempsey, 1974; Leatherwood and Dempsey, 1976). Until recently, however, many of these developments have viewed the passenger subject as a perfect physical transducer, reacting to the physical input to produce an output in the form of a ride quality judgment. Although this purely psychophysical approach is necessary and, indeed, productive, it does yield a wide range of individual differences that should be accounted for if one is to predict accurately an individual's response. In other words, it has been recognized for some time that, in a judgmental situation, the subject is not a "null" instrument; he brings into the situation certain expectations and biases that vary as a function of that subject's past experience. These expectations and biases, in turn, will serve to modulate his subjective responses to that situation. Attempts have been made to account for these individual differences brought into the judgmental situation with perhaps the most famous attempt being that proposed by Helson's adaptation-level theory (Helson, 1964).

Therefore, if a model of ride-quality judgment is to be effective for the individual subject or passenger, it should take into account in some way the potential impact of the subject's background experiences and personality. If there are personality and subjective variables that vary ride-quality judgments independent of the physical parameters of the situation, these personality and subjective variables should be identified, the relationships between these variables and ride-quality judgments should be quantified, and based on these identifications and quantifications, it should be possible to equate subjects with respect to these variables. In other words, the identification of the variables and their relationships should permit the "calibration" of subjects to a common level prior to exposure to the judgmental stimulation.

The purpose of the present investigation was, therefore, to identify personality and demographic correlates, as well as physical correlates, of ride-quality judgments in a field situation; namely, in selected passenger-train ride segments.

METHOD

The general methodology employed in this investigation is as follows: (1) An attempt was made to recruit subjects from a wide variety of ages, socioeconomic strata, and educational backgrounds from the communities around

Norfolk, Virginia. (2) A battery of paper-and-pencil tests was administered to each subject to provide a number of personality and behavioral measures. (3) Each subject was requested to make ride-quality judgments on approximately 40 ride segments during a 2-hour, regularly-scheduled passenger train ride. (4) Physical measurements were made on each of the ride segments--vibratory frequencies and accelerations in six degrees of freedom and noise intensities within the passenger car. (5) Correlation and regression analyses were computed using both the physical measurements and subjective measures as predictors of the criterion, ride-quality judgments.

Subjects

A total of 82 adult subjects, 49 females (mean age 34.32; standard deviation 11.05) and 33 males (mean age 31.35; standard deviation 9.53) were recruited through the Performance Assessment Laboratory of the Old Dominion University and through local service organizations within the Norfolk area. Two groups of 41 subjects each participated in the investigation on two different days. The subjects were paid for their participation in the amount of $25 for approximately 8 hours time.

Passenger Train Car and Route

On each of the two days, regularly routed passenger cars of the AMTRAK Norfolk, Virginia to Petersburg, Virginia were utilized. The passenger car had 52 forward-facing passenger seats arranged four abreast with an aisle separating the middle two seats. For the duration of the ride, the seats were adjusted to the upright position. The front row, the back row, and a middle row of seats were reserved for experimenters and recording equipment and with those exceptions, subjects were allowed to select seats as they wished. The route selected (Norfolk to Petersburg) was dictated by the fact that it was the only route leaving the Norfolk area that permits subjects to go and return within a single day. The duration of the route was approximately 110 minutes. After a layover of approximately 1 hour, the subjects returned to Norfolk via the Petersburg to Norfolk AMTRAK route.

Paper and Pencil Tests and Questionnaires

A battery of paper-and-pencil tests was selected to provide psychological measures for each of the subjects; the battery consisted of (a) the Adjective Check List, (b) the Eysenck Personality Questionnaire, (c) the Group Embedded Figures Test, (d) the Myers-Briggs Type Indicator, and (e) the State-Trait Anxiety Index. The Adjective Check List is a 300-word list on which the subject is to respond by checking the words of the list that are self-descriptive; the subject's responses on this list provide for a total of 23 scale measures (Gough and Heilbrun, 1965). The Eysenck Personality Questionnaire is a 90-item questionnaire that provides the three personality scales of Extraversion, Neuroticism, Psychoticism, and a Lie scale (Eysenck and Eysenck, 1975). The Group Embedded Figures Test, an 18-problem form identification test, provides two measures of field independence (Ditman, Raskin, and Witkin, 1971). The Myers-Briggs Type Indicator, a 166-item personality questionnaire, provides a total of eight subscales which subsequently can be combined for the four basic scales of the test (Myers, 1962). The State-Trait Anxiety Index is a 40-question test that provides measures of temporary (State) and residual (Trait) arousal. Table 1 summarizes the paper-and-pencil tests administered and the scales derived therefrom.

In addition to the paper-and-pencil tests, each subject was asked to complete a pre-departure and a post-experiment questionnaire. The pre-departure questionnaire served to obtain from each subject demographic data concerning age, sex, weight, height, educational background, income, experience on trains, last experience on trains, condition of health in general, medical history with respect to specific ailments, and current medication if any. The post-experiment questionnaire was an attempt to solicit from the subjects subjective information as to how they arrived at their ride quality judgments; specifically, they were questioned concerning their rank-ordering of a number of physical variables, their expectations concerning the ride, recommendations to friends based on their rides, rank-ordering of mass-transit systems in terms of preference, and their criteria for choosing a mass-transit system for personal travel. Copies of both the pre- and post-questionnaires are attached to this report as an appendix.

Table 1. Summary of Paper-and-Pencil Tests Administered and Scales Derived from the Tests.

	Paper-and-Pencil Test	Code*	Scale
1.	Adjective Check List	Def	Defensiveness
2.	Adjective Check List	Fav	Favorable Characteristics
3.	Adjective Check List	Unf	Unfavorable Characteristics
4.	Adjective Check List	Scf	Self-Confidence
5.	Adjective Check List	Scl	Self-Control
6.	Adjective Check List	Lab	Lability
7.	Adjective Check List	Paj	Personal Adjustment
8.	Adjective Check List	Ach	Need for Achievement
9.	Adjective Check List	Dom	Need for Dominance
10.	Adjective Check List	End	Need for Endurance
11.	Adjective Check List	Ord	Need for Order
12.	Adjective Check List	Int	Need for Intraception
13.	Adjective Check List	Nur	Need for Nurturance
14.	Adjective Check List	Aff	Need for Affiliation
15.	Adjective Check List	Het	Need for Heterosexuality
16.	Adjective Check List	Exh	Need for Exhibition
17.	Adjective Check List	Aut	Need for Autonomy
18.	Adjective Check List	Agg	Need for Agression
19.	Adjective Check List	Chg	Need for Change
20.	Adjective Check List	Suc	Need for Succorance
21.	Adjective Check List	Aba	Need for Abasement
22.	Adjective Check List	Dfr	Need for Deference
23.	Adjective Check List	Cr	Counseling Readiness
24.	Eysenck Personality Questionnaire	Psy	Psychoticism
25.	Eysenck Personality Questionnaire	Eext	Extraversion
26.	Eysenck Personality Questionnaire	Neu	Neuroticism
27.	Eysenck Personality Questionnaire	L	Lie
28.	Group Embedded Figure Test	GEF1	Field Independence No. 1
29.	Group Embedded Figure Test	GEF2	Field Independence No. 2
30.	Myers-Briggs Type Indicator	Mext	Extraversion
31.	Myers-Briggs Type Indicator	Mint	Intraversion
32.	Myers-Briggs Type Indicator	Msen	Sensing
33.	Myers-Briggs Type Indicator	Mitu	Intuition
34.	Myers-Briggs Type Indicator	Mthi	Thinking
35.	Myers-Briggs Type Indicator	Mfee	Feeling
36.	Myers-Briggs Type Indicator	Mjud	Judgment
37.	Myers-Briggs Type Indicator	Mper	Perception
38.	State-Trait Anxiety Inventory	Sta	State
39.	State-Trait Anxiety Inventory	Tra	Trait

* Code will be used for purposes of reference in the remainder of this report.

Apparatus

The equipment for providing the vibratory and noise levels was provided and operated by personnel of the Noise Effects Branch of NASA-Langley Research Center. Power for the equipment was supplied from the train's electrical system, although all components were portable and capable of operating from batteries in case of train power failure. Vibrations on the lateral, vertical, and longitudinal axes were measured by two, NASA-designed accelerometers, located on the floor in the middle and rear of the passenger car; pitch, roll, and yaw were measured by angular accelerometers similarly placed. The six individual axis signals were recorded on separate FM channels by two Lockheed Model 417 tape recorders. Noise levels were recorded by Nagra S-J FM tape recorders, placed at the middle and rear of the car. Vibration and noise recorders were synchronized by electronic signals.

Cueing boxes for specifying to the subjects the onset and offset of each ride segment as well as the segment number were located at the front and middle of the car at a height of 30 inches. Each cueing box consisted of a circular 2-inch blue-jeweled light that was manually activated at the beginning of each ride segment, as well as a digital display of the segment number. Onset of the light triggered an electronic signal to the tape recorders, ensuring that segments of the physical measurement would correspond with rated segments.

Procedure

Orientation and pretest.--Subjects assembled at approximately 10:00 A.M. at Old Dominion University on their scheduled day. Packets containing a ride discomfort rating scale booklet, pre-departure and post-experiment questionnaires, and paper-and-pencil test materials, all numerically coded so as to ensure anonymity, were distributed along with pens and clipboards. A brief presentation of the day's events, possible risks involved in the train ride, and subject responsibilities and rights were administered by the chief experimenter. Subjects were informed of their right to withdraw from participation at any time and for any reason during the day, although they were required to make the return train ride with the group if they withdrew after entering the train. Signed "Informed Consent" forms were collected and the pretest phase began. It was stressed that no personal identifiable information was to be written on any of the tests and that test scores would remain anonymous. At this time, the Group Embedded Figures Test and the Myers-Briggs Type Indicator were administered. At 12:00 noon, subjects were served a box lunch and were allowed a 5-minute break before the 15-minute charter bus ride to the train station.

<u>Train ride and discomfort ratings</u>.--Immediately upon boarding, the subjects were asked to complete the pre-departure questionnaire. Subsequently, the subjects were asked to remove their ride-quality rating scale booklet from their packets and instructions were read to them as they read the written instructions attached to the booklet. The booklet provided the subjects with 9-point unipolar line scales labeled "zero discomfort" and "maximal discomfort" at the extreme ends. It should be noted that earlier use of this scale (cf. Kirby, Coates, Mikulka, Dempsey, and Leatherwood, 1975) demonstrated that this scale avoids the problems inherent in subjective interpretation of semantic labels (see Osborne and Clarke, 1974) and provides at least interval scales of psychological discomfort. The booklet contained one scale per page, numbered consecutively to correspond with the ride segment being evaluated. Subjects were instructed to complete each scale by making a single check along the line between 0 and 8 which reflected the peak discomfort associated with the ride segment, including vibration, noise, temperature, and other ride quality factors. Subjects were further instructed not to discuss their ratings with other participants.

The specified ride segments to be rated were begun approximately 15 minutes after the start of the trip, when the train had reached normal travelling speeds on open track through countryside. A single 10-minute delay occurred for both groups about 30 minutes into the rating phase when the train made its regularly scheduled stop in Suffolk, Virginia. Each rated ride segment was 30 seconds in duration, with approximately 1 1/2 minutes between successive segments. Subjects were allowed to talk between but not during the ride segments. Ten seconds prior to each ride segment, a "ready" signal was verbally announced via a loudspeaker; the beginning of the segment was announced with the words, "Begin ride number _____," and by illuminating the cueing lights. The termination of each segment was marked by the words, "Stop. Rate ride number _____," and the offset of the cueing light. Ride segments 1 through 3 for each group were used as practice trials to ensure that equipment was operating properly and that rating instructions were understood. During the actual rating phase, subjects in the first group rated a total of 42 ride segments and also made three average evaluations after the 15th, 30th, and 45th segments; in the second group 39 ride segments were rated, with average evaluations after the 16th, 33rd, and 42nd segments. The entire rating procedure took slightly more than 1 1/2 hours for each group and ended approximately 20 minutes before reaching Petersburg.

Post test.--Immediately after the rating phase, subjects were asked to complete the State-Trait Anxiety Index and the post-experiment questionnaire. At Petersburg, staff and participants departed the train for a 1-hour delay before the return trip; cold plate meals were served in a local restaurant. Upon reboarding, subjects were asked to complete the Eysenck Personality Questionnaire and the Adjective Check List. Upon returning the completed packets with rating scales and test materials, each subject received his or her participation pay.

RESULTS

Data analyses for this investigation included data from a total of 80 subjects, 41 from Group #1 and 39 from Group #2; the data from two subjects had to be omitted due to incomplete ratings of ride quality. A total of 42 ride segments were included in the analysis for the subjects of Group #1 and 39 ride segments were included for subjects of Group #2.

Pre-Departure Questionnaire

Table 2 presents a summary of the data collected from all 80 subjects on the pre-departure questionnaire. It should be noted that the subject sample was a relatively heterogenous group in terms of all categories and appears to be representative of the general population. It did not appear that there was an inordinate imbalance for any categories.

Table 2. Summary of Data from Pre-Departure Questionnaire (N = 80).

Question	Data Summary
1. Age	Mean = 33.15 yrs; Standard Deviation = 10.636
2. Sex	33 (41.25%) Males; 47 (58.75%) Females
3. Weight	Mean = 151.51 lbs; Standard Deviation = 71.077
4. Height	Mean = 66.41 in.; Standard Deviation = 4.407
5. Education	3 3.75% Did not finish high school
	15 18.75% Completed H.S. but no college
	8 10.00% One year of college
	11 13.75% Two years of college
	6 7.50% Three years of college
	23 28.75% Completed college
	8 10.00% Masters Degree
	6 7.50% Doctoral Degree
6. Approximate Household Income	11 13.75% Under $5000
	13 16.25% $5000 to $9999
	16 20.00% $10000 to $14999
	16 20.00% $15000 to $19999
	13 16.25% $20000 to $24999
	5 6.25% $25000 to $29999
	2 2.50% $30000 to $34999
	4 5.00% More than $35000
7. Experience on Trains	15 18.75% Never ridden a train before
	13 16.25% Had ridden a train once before
	21 26.25% Had ridden 2-5 times
	6 7.50% Had ridden 6-10 times
	25 31.25% Had ridden more than 10 times
8. Last Experience on Train	15 18.75% Never
	3 3.75% Less than one year ago
	12 15.00% Between 1-5 years ago
	17 21.25% Between 6-10 years ago
	33 41.25% More than 10 years ago
9. Condition of Your Health	51 63.75% Excellent
	21 26.25% Very good
	8 10.00% Good

(cont'd)

Table 2. Summary of Data from Pre-Departure Questionnaire (N = 80). Concluded.

Question	Data Summary		
10. Have you had or do you have?	13	16.25%	Frequent or severe headaches
	7	8.75%	Dizziness of fainting spells
	9	11.25%	Eye trouble
	0	0.00%	Heart trouble
	11	13.75%	High or low blood pressure
	2	2.50%	Pain or pressure in chest
	2	2.50%	Periods of unconsciousness
	3	3.75%	Hearing problems
	1	1.25%	Head injury
	0	0.00%	Epilepsy
	0	0.00	Problems with maintaining balance
11. Currently on medication?	8	10.00%	Yes

Post-Experiment Questionnaire

A summary of the data collected from all subjects on the post-experiment questionnaire is presented in Table 3. While the summary is, for the most part, self-explanatory, it should be noted that the summary procedure utilized in the case of questions requiring subjects to rank certain alternatives involves reporting the mean rank assigned to each of the alternatives. The resulting mean ranks for the alternatives will present an ordinal scaling of the ranked alternatives. Of special interest in this experiment is the resulting scale of Question 1--the ranking of physical characteristics of a ride as they contributed to the subjects' judgments of the ride quality. The scale resulted in the following rank ordering of the characteristics (in decreasing importance): (1) seat comfort, (2) temperature, (3) side-to-side motion, (4) up-and-down motion, (5) noise, (6) presence of smoke, (7) crowdedness, and (8) lighting. It should be noted that the rankings of the first five characteristics were sufficiently close to warrant the consideration of those characteristics as a group with the last three characteristics considered as a separate group of significantly lower importance that the first group.

The resulting rankings of Question 6 are also noteworthy in terms of what the subjects see as the determining considerations for their selection of a mass transit system for personal trips. According to the subjects used in this investigation, the following is a ranking of the considerations for selecting a mass transit system for personal use, ranked in decreasing importance: (1) time savings, (2) convenience, (3) comfort, (4) safety, (5) reliability, (6) services on board, (7) surroundings, and (8) ability to work enroute. The mean ranks for time savings and convenience were sufficiently close to consider them equivalent, as were the ranks of comfort and safety; in other respects, the scale appeared to discriminate clearly among the considerations.

Paper-and-Pencil Measures

Summary data for the various scales and measures derived from the paper-and-pencil tests are presented in Table 4. In all cases, the data reported are mean values resulting from standard administration and scoring of the

Table 3. Summary of Data from Post-Experiment Questionnaire (N = 80).

<u>Question 1</u>: Rank the following in terms of importance (1 representing most important) in determining your judgments during the ride.

Noise	Mean Rank = 3.69
Temperature	Mean Rank = 3.37
Lighting	Mean Rank = 5.53
Seat comfort	Mean Rank = 3.35
Up-and-down motion	Mean Rank = 3.54
Side-to-side motion	Mean Rank = 3.41
Presence of smoke	Mean Rank = 5.36
Crowdedness	Mean Rank = 5.48

<u>Question 2</u>: Was the ride more comfortable or less comfortable than expected?

67	83.75%	More comfortable
13	16.25%	Less comfortable

<u>Question 3</u>: Based on this experience, would you recommend to your family that they [illegible] a train on their next long trip?

69	86.25%	Would recommend
11	13.75%	Would not recommend

<u>Question 4</u>: Rank order the mass transit system you would have most likely used prior to this trip (1 indicates first choice).

Airplane	Mean Rank = 1.12
Bus	Mean Rank = 2.72
Train	Mean Rank = 2.07

<u>Question 5</u>: Since this trip, rank the mass transit systems you would most likely use on your next trip.

Airplane	Mean Rank = 1.17
Bus	Mean Rank = 2.88
Train	Mean Rank = 1.89

<u>Question 6</u>: Rank the following considerations determining which mass transit system you would choose for your next trip (1 indicates most important).

Comfort	Mean Rank = 3.06
Convenience	Mean Rank = 2.86
Reliability	Mean Rank = 3.59
Safety	Mean Rank = 3.09
Time savings	Mean Rank = 2.83
Ability to work enroute	Mean Rank = 6.69
Services on board	Mean Rank = 5.48
Surroundings	Mean Rank = 6.28

Table 4. Summary Statistics for Paper-and-Pencil Tests (N = 80).

Paper-and-Pencil Test	Scale Code	Mean	Standard Deviation
Adjective Check List	Def	48.99	8.535
	Fav	48.93	17.731
	Unf	46.50	6.833
	Scf	44.69	9.321
	Scl	49.65	7.690
	Lab	49.01	9.625
	Paj	49.09	9.262
	Ach	47.58	9.774
	Dom	49.46	9.[illegible]35
	End	44.43	22.113
	Ord	34.71	5.159
	Int	20.89	12.899
	Nur	9.78	9.286
	Aff	36.94	21.679
	Het	14.24	11.739
	Exh	32.63	8.344
	Aut	37.05	11.353
	Agg	61.98	9.394
	Chg	52.30	17.419
	Suc	37.94	7.222
	Aba	42.56	8.381
	Dfr	34.65	9.667
	Cr	58.49	13.207
Eysenck Personality Questionnaire	Psy	2.36	1.864
	Eext	14.19	5.151
	Neu	8.98	5.170
	L	6.29	4.029
Group Embedded Figures Test	GEF1	3.74	2.623
	GEF2	5.60	2.603
Myers-Briggs Type Indicator	Mext	11.39	4.339
	Mint	8.13	4.259
	Msen	9.41	5.552
	Mitu	8.10	3.999
	Mthi	5.53	3.884
	Mfee	8.46	3.525
	Mjud	10.05	5.146
	Mper	10.96	9.802
	MExIn	3.26	8.525
	MSeIt	1.31	9.388
	MThFe	- 2.94	7.273
	MJuPe	- 0.91	12.773
State-Trait Anxiety Inventory	Sta	27.95	6.298
	Tra	33.40	7.605

tests presented. It should be noted that four additional scales have been added to those listed for the Myers-Briggs Type Indicator in Table 1; the four additional scales are derived measures of that test where MExIN is the difference between each individual's Mext scale value and his Mint scale value, and MSeIt is the difference between the Msen value and the Mitu value. Likewise, MThFE is a similar combination of the Mthi and Mfee values, and the MJuPe is derived from the Mjud and Mper values. These derived scales are the ones typically employed with the use of the Myers-Briggs Type Indicator; however, for purposes of this project, it was decided that all scale values should be included. In all cases, the data presented in Table 4 are in agreement with the norms established for the tests used.

Physical Measures

The FM tape recordings of the physical variables for each of the ride segments were subjected to analog-to-digital conversions and the resulting data were analyzed using a spectral-density analysis computer program provided by the Noise Effects Branch of NASA Langley Research Center. Due to the relatively low levels and low variability of the vibrations experienced on the two train rides, the use of vibration measures by frequency band was prohibited in subsequent analyses. Instead, vibration measurements were represented by total spectrum measures of the vibratory accelerations in each of the six axes. Nevertheless, the accelerations in the longitudinal axis were so slight as to render them useless, and therefore, will not be reported here. Table 5 presents summary data for acceleration levels (in g-rms) in each of the remaining five axes, noise levels unweighted and A-weighted, and subjects' ratings of ride quality for each of the two groups of subjects. These data were analyzed separately for the two groups because of the unequal number of ride segments involved in the measurements. The means for Group 1 represent means taken over 42 ride segments while the means for Group 2 represent means taken over 39 ride segments. It should be noted that for the acceleration means, the obtained values represent relatively low levels; in fact, the obtained levels represent values below those typically found to affect subjects' ratings of ride quality (see Leatherwood and Dempsey, 1976). It should be further noted that the variability of these

Table 5. Summary Statistics for Physical and Ride-Quality Judgment Variables and Mean Pearson-Product-Moment Correlation Coefficients Between Physical Variables and Ride-Quality Ratings.

Subject Group	Variable	Mean*	Standard Deviation	Mean r**
Group #1	Vertical g-rms	0.03383	0.00649	.006
	Horizontal g-rms	0.02038	0.00634	.017
	Roll g-rms	0.01203	0.00381	.090
	Pitch g-rms	0.00724	0.00074	-.112
	Yaw g-rms	0.00529	0.00213	-.056
	dB (Unweighted)	90.30952	1.50421	.015
	dB (A-weighted)	65.97619	2.18813	.056
	Rating**	2.14054	1.21042	--
Group #2	Vertical g-rms	0.04556	0.00673	.070
	Horizontal g-rms	0.02403	0.00486	.102
	Roll g-rms	0.02063	0.00378	.099
	Pitch g-rms	0.01130	0.00093	.030
	Yaw g-rms	0.02277	0.00437	.076
	dB (Unweighted)	90.76923	1.12039	.090
	dB (A-weighted)	65.43590	3.86295	.049
	Rating**	2.73865	1.78610	--

* Based on a total of 42 ride segments for Group #1 and a total of 39 ride segments for Group #2.

** Based on a total of 41 subjects for Group #1 and 39 subjects for Group #2.

measures between ride segments, as represented by the standard deviations, is extremely small. Likewise, the noise measures indicated that the noise levels were not high enough to be rated as annoying (Kryter, 1970), and were relatively invariant from segment to segment for both groups.

Table 5 also presents the Pearson-product-moment correlation coefficient for each of the physical measures with the subject's rating of the ride segments; correlations were computed for each subject across ride segments, and the means of these correlations across subjects are reported. It should be noted that none of the physical measures for either of the subject groups was significantly correlated with the subjects' ratings of ride quality. Based on previous results, this lack of correlation between physical measures and judgments of ride quality may be surprising, but based on the extremely low variability between ride segments and low mean vibratory levels, it is not so surprising in that subjects simply did not receive discriminable stimulation.

Paper-and-Pencil Correlates of Ride Quality Judgments

Correlational analyses were computed to determine the extent to which a subject's mean ride-quality judgment was related to demographic, personal, and paper-and-pencil measures of that subject. Table 6 presents a summary of this analysis, reporting each of the individual variables and its associated Pearson-product-moment correlation coefficient with mean ride-quality rating. It should be noted that the sex, education, income, and experience variables used categorical data for the computation of this parametric statistic, using an increasing digital code for each variable for this purpose. For example, sex was coded "1" for made and "2" for female and treated statistically as interval data for purposes of this analysis. Likewise, income "Under $5000" was coded a "1," "$5000 to $9999" was coded a "2," etc. Treating nominal and ordinal data as interval data will give you equivalent results to using a nonparametric statistic; however, the caution regarding generalizations on these data is well-founded--generalizations are limited to the original scale of measurement (cf. Harris, 1975).

As indicated in Table 6, there are 9 variables that correlate significantly with the ride-quality judgments beyond the .01 level, 5 beyond the .05 level,

Table 6. Summary of Pearson-Product-Moment Correlation Coefficients of Demographic, Personal, and Paper-and-Pencil Measures With Mean Ride-Quality Ratings.†

Variable	r	r^2	Variable	r	r^2
1. Age	-.262***	.0686	26. ACL--Chg	-.289***	.0835
2. Sex	-.093	.0086	27. ACL--Suc	-.159	.0253
3. Weight	.066	.0044	28. ACL--Aba	-.108	.0117
4. Height	.103	.0106	29. ACL--Dfr	.120	.0144
5. Education	.207*	.0428	30. ACL--Cr	.102	.0104
6. Income	-.230**	.0529	31. EPQ--Psy	.345***	.1190
7. Experience	.012	.0001	32. EPQ--Eext	.193*	.0372
8. ACL--Def	-.169	.0286	33. EPQ--Neu	.173	.0299
9. ACL--Fav	.175	.0306	34. EPQ--L	-.300***	.0900
10. ACL--Unf	.281**	.0790	35. GEF1	.146	.0213
11. ACL--Scf	.067	.0045	36. GEF2	.044	.0019
12. ACL--Scl	-.167	.0279	37. MB--Mext	.093	.0086
13. ACL--Lab	.244**	.0595	38. MB--Mint	-.139	.0193
14. ACL--Paj	-.387***	.1498	39. MB--Msen	-.377***	.1421
15. ACL--Ach	-.185*	.0342	40. MB--Mitu	.338***	.1142
16. MCL--Dom	-.191*	.0365	41. MB--Mthi	-.120	.0144
17. ACL--End	.036	.0013	42. MB--Mfee	.116	.0135
18. ACL--Ord	-.139	.0193	43. MB--Mjud	-.357***	.1274
19. ACL--Int	.056	.0031	44. MB--Mper	.153	.0234
20. ACL--Nur	-.166	.0276	45. MB--ExIn	.117	.0137
21. ACL--Aff	-.162	.0262	46. MB--SeIt	-.367***	.1347
22. ACL--Het	.148	.0219	47. MB--ThFe	-.120	.0144
23. ACL--Exh	-.273**	.0745	48. MB--JuPe	-.261**	.0681
24. ACL--Aut	-.214*	.0458	49. Sta	.178	.0317
25. ACL--Agg	-.169	.0286	50. Tra	.135	.0182

† Degrees of freedom for this analysis = 78

* P less than .10

** P less than .05

*** P less than .01

and 5 beyond the .10 level of significance. Subsequently, these data were submitted to a stepwise multiple regression analysis using the BMD02 computer program. Specifically, the 50 variables listed in Table 6 were submitted as potential predictors in a multiple regression of subjects' mean ride quality ratings. The standard options of the BMD02R program were used with the exception that a more stringent criterion was used for the termination of the regression. Specifically, the stepwise regression was terminated when the F-test for entry to the regression fell below 1.0. Table 7 presents the results of the multiple regression analysis, providing each of the steps in the regression, the variable entered on that step, the final B-weight for that variable in the regression equation, the multiple R at that step, its associated R^2 and the increase in R^2 associated with the entry of that variable. In summary, the regression analysis indicated that with 26 predictors, a multiple correlation coefficient of .878 was obtained, accounting for 77.13 percent of the variation in mean ride-quality judgments.

DISCUSSION

Of the results presented above, attention should be drawn first to the correlational analysis of the physical measures with the subjects' ratings of ride quality. As indicated earlier, the lack of correlation between the subjects' ratings and the physical measures is somewhat surprising based on data from most studies of vibration, noise, and ride-quality ratings (e.g., Dempsey, Leatherwood, Drezek, 1976; Leatherwood and Dempsey, 1976). However, as one notes the levels of physical stimulation and the variability of these stimulations across ride segments, one is not surprised that the subjects were presented with vibrations and noise that were not uncomfortable and were asked to judge the quality of ride segments that, to them, were not discriminably different. It is suggested, therefore, that the failure to obtain typically found correlations lies in the fact that the subjects did not have a basis in the physical parameters for varying their responses. Subjects' responses did vary, however, and if they did not vary on the basis of the physical parameters, what was the basis for variability? For the most part, it can be assumed that an individual subject's ratings varied randomly around his or

Table 7. Summary of Stepwise Multiple Regression of Individual Variables Predicting Mean Ride-Quality Ratings.*

Step	Variable Entered	Final Coefficient	R	R^2	Increase in R^2
1.	ACL--Paj	-0.300	.3871	.1498	.1498
2.	ACL--Lab	--	.4840	.2343	.0845
3.	ACL--Fav	0.040	.5667	.3212	.0869
4.	EPQ--L	-0.095	.6120	.3746	.0534
5.	ACL--Aff	-0.019	.6408	.4106	.0360
6.	Weight	0.006	.6729	.4528	.0422
7.	MB--Mjud	-0.019	.6964	.4850	.0322
8.	Income	-0.129	.7163	.5131	.0281
9.	Education	0.217	.7320	.5358	.0228
10.	MB--Mthi	-0.071	.7460	.5565	.0206
11.	ACL--Nur	-0.026	.7562	.5718	.0153
12.	ACL--Het	0.028	.7673	.5888	.0170
13.	ACL--Dfr	-0.039	.7791	.6070	.0182
14.	ACL--Aut	-0.016	.7888	.6222	.0152
15.	Sex	-1.022	.7967	.6347	.0125
16.	Height	-0.111	.8100	.6560	.0213
17.	EPQ--Neu	0.071	.8236	.6783	.0223
18.	ACL--Chg	-0.013	.8283	.6860	.0078
19.	ACL--Suc	0.009	.8337	.6950	.0090
20.	MB--Mext	-0.514	.8388	.7036	.0086
21.	MB--ExIn	0.234	.8519	.7258	.0222
22.	EPQ--Eext	0.056	.8577	.7357	.0099
23.	ACL--Int	0.018	.8631	.7449	.0092
24.	ACL--Ach	-0.049	.8674	.7523	.0074
25.	ACL--Crs	0.009	.8714	.7594	.0071
26.	ACL--Scl	0.038	.8747	.7652	.0058
27.	ACL--Dom	0.037	.8782	.7713	.0061
28.	ACL--Lab (removed)	--	.8782	.7713	.0000
	Constant	13.920			

* The data of a total of 80 subjects were included in this analysis.

her judgmental adaptation level. For this reason, it is judged that the lack of physical variability served as a mixed blessing in that it allowed us to observe potential correlates of a mean judgmental level uncontaminated by physical modulators.

Consequently, in presenting subjects with physical stimuli that were essentially ambiguous, we inadvertently presented a situation that is analogous to a projective technique, and, therefore, the only determining factor for their level of ride-quality judgments must lie in the adaptation levels brought into the situation.

The multiple regression analysis of ride-quality judgments and the various individual measures provided evidence that the mean level of judgment could be accounted for to an appreciable degree by the personality and demographic measures. Although shrinkage is expected in the multiple R with another sample of subjects, the obtained R and its regression provide a good basis for attempting to predict mean level of ride quality judgments in other, hopefully more variable, situations. Such an attempt would then provide a test of the validity of the predictive equation. In this respect, however, two words of caution are in order.

Firstly, the regression equation was based on the data of a single sample of 80 subjects, and the multiple regression provides a biased estimator of the population values of R and R^2. Unbiased estimates of R reduce it from the .8782 value reported in Table 7 to .8155, with similar reductions in R^2 from the previous value of .7713 to .6650. Even with these corrections, however, one must realize that the regression equation was based on this single sample and that confidence in the equation will depend upon a test with a different sample.

Secondly, the modelling of ride quality judgments could possibly be enhanced with the introduction of this or similar equations if the effect of the addition of discriminable physical stimuli would simply serve as a linear modifier of the predicted judgmental level. However, another possibility does exist--the discriminable physical stimulation levels may serve to interact with the predictors of the equation differentially. In other words, a second test is called for, one in which the predictive equation is used in conjunction with physically discriminable stimuli in an attempt to determine if the equation provides an acceptable fit to the data.

In summary, the present investigation provides a suggestive approach to the improvement of prediction of ride-quality judgments; the evaluation of the effectiveness of the approach will have to wait for both of the above tests.

Respectfully Submitted:

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APPENDIX A

Samples of Pre-Departure and Post-Experiment Questionnaires Used in This Investigation

SUBJECT NO. ___________

PERFORMANCE ASSESSMENT LABORATORY
Old Dominion University

Pre-Questionnaire

This questionnaire is to obtain from you responses of a personal nature that might be useful to us in evaluating the data we obtain from you today. I remind you that all responses to this questionnaire will be treated with the strictest of confidence.

1. Age ______

2. Sex ______

3. Weight ______

4. Height ______

5. Education: Check the category below that applies to you.

___ Did not complete elementary school
___ Did not complete high school
___ Completed high school but no college
___ One year of college
___ Two years of college
___ Three years of college
___ Completed college
___ Masters degree
___ Doctoral degree

6. Approximate household income (Before taxes): Check one

___ Under $5000
___ $5000-$9,999
___ $10,000-14,999
___ $15,000-19,999
___ $20,000-24,999
___ $25,000-29,999
___ $30,000-34,999
___ $35,000 or more

7. Experience on Trains: Check one of the below to indicate how much experience you have had on trains.

___ Have never ridden one before
___ Rode one once before
___ Have ridden between 2-5 times
___ Have ridden between 6-10 times
___ Have ridden more than 10 times

8. When was the last time you rode a train?

___ Never
___ Less than one year ago
___ Between 1-5 years ago
___ Between 6-10 years ago
___ More than 10 years ago

9. What is the condition of your health?

___ Excellent
___ Very good
___ Good
___ Poor
___ Very Poor

10. Have you ever had or have you now: (Please check at left of each item)

Yes	No	Don't Know	
___	___	___	Frequent or severe headaches
___	___	___	Dizziness or fainting spells
___	___	___	Eye trouble
___	___	___	Heart trouble
___	___	___	High or Low Blood Pressure
___	___	___	Pain or pressure in chest
___	___	___	Periods of unconsciousness
___	___	___	Hearing problems
___	___	___	Head injury
___	___	___	Epilepsy
___	___	___	Problems with maintaining balance

11. Are you currently on any medication? ___ Yes ___ No

12. If the answer to the above question is "Yes", please indicate the purpose of the Medication: ______________________________

SUBJECT NO. ______

PERFORMANCE ASSESSEMENT LABORATORY
Old Dominion University

Post-Questionnaire

This questionnaire is intended to provide us with information as to how you arrived at your judgments of ride quality on this trip.

1. How important are each of the following in determing your judgments during the train ride? Rank the following using the numbers from 1 to 8 with 1 representing the most important, and 8 representing the least important.

___ Noise ___ Up and down motion (bouncing)

___ Temperature ___ Side to side motion (rolling)

___ Lighting ___ Presence of smoke

___ Seat Comfort ___ Crowdedness

2. Was the ride from Norfolk to Petersburg more comfortable or less comfortable than you had expected?

_____ More comfortable

_____ Less Comfortable

3. Based on your experience on this ride (disregarding ride-quality judgments), would you recommend to your family and friends that they ride on a train on their next long trip?

_____ Would recommend

_____ Would not recommend

4. Prior to this trip, rank order the mass transit system you would most likely use on your next trip.

____ Airplane

____ Bus

____ Train

5. Since you have made this trip, rank order the mass transit systems you would most likely use on your next trip. Use 1 to indicate the first choice to 3 for last choice.

____ Airplane

____ Bus

____ Train

6. Rank order the following considerations determining which mass transit system you would choose for your next trip. Rank 1 for the most important consideration and 8 for the least important consideration.

___ Comfort

___ Convenience

___ Reliability

___ Safety

___ Time savings

___ Ability to work enroute

___ Services on board

___ Surroundings