Psych 5741: Graduate Statistics (aka Data Analysis)
Final Exam, Fall 1996

Note: All questions are worth 3 points.

Problem A

This is another problem based on examples from Kenakin (1987), *Pharmacologic analysis of drug-receptor interactions*.

"Much pharmacologic inference derives from comparisons of tissue sensitivities to drugs before and after [various levels of drug intervention]. This approach permits the use of null methods, so vital to pharmacologic procedures because stimulus-response mechanisms usually are unknown. Thus, the sensitivity of a tissue to a drug can be quantified by a dose-response curve, then the preparation altered in some way (e.g., addition of a receptor antagonist) and the effect of the alteration measured by a repeated quantification of tissue sensitivity. Ideally, these measures should be independent of the level of response; otherwise the null requirement is not met, and the data are much less useful. Frequently, ... straight lines are generated that differ in location (along the *x* axis) and *somewhat* in slope. This latter fact greatly complicated interpretation of the data, because how much the lines differ in location then depends on the value of the ordinate (i.e., where along the line the difference is measured); this makes the analysis cumbersome. However, if the lines were parallel, there would be no dependence of location on ordinate values, and an unambiguous measurement would result. Therefore, and unbiased test of whether... straight lines truly are or are not parallel [and whether the lines are truly straight] can be useful." (pp. 149-150)

Model comparison methods are obviously appropriate for answering such questions. Specify the model comparisons (and define any new variables you need to construct) to answer the following pharmacologic questions. The following variables have already been defined:

DEP	percentage depression of guinea pig atrial contractions
ADEN	log dose concentration of the drug adenosine
DIAZ	log dose concentration of the antagonist drug diazepam (aka Valium)

1. Is the log dose concentration of adenosine by itself a useful predictor of the percentage depression of guinea pig atrial contractions?

2. Is a more complicated model than a line necessary to describe the relationship between log dose concentration of adenosine and percentage depression of guinea pig atrial contractions?

3. As a set, do diazepam and adenosine log dose concentrations predict percentage depression of guinea pig atrial contractions?

4. Is diazepam indeed an antagonist for adenosine? That is, are the lines relating adenosine concentrations to percentage depression shifted along the *x* (adenosine) axis for different levels of diazepam? Indicate the coefficient of interest in this question and what its sign would be if diazepam is indeed an antagonist. (Note: an antagonist binds to the same receptors as the drug and thus reduces the effect of the drug.)

5. The key question raised in the introduction to this problem: Are the lines relating adenosine concentration to percentage depression parallel across levels of diazepam?

6. Assume that the relationship between adenosine concentration and percentage depression of atrial contractions is quadratic. Does parallelism still hold? That is, is the same quadratic curve for adenosine obtained across levels of diazepam?

7. Diazepam itself may have a quadratic relationship with percentage depression of atrial contractions. Supposing that it does, does the quadratic effect of adenosine depend on the quadratic effect of diazepam?

Problem B

A researcher in animal learning is interested in classically conditioned responses to shock (the unconditioned stimulus) when it is paired with a tone. For each of 10 animals, she first calculates the proportion of time the animal freezes when placed in a novel environment and the tone turned on. She then exposes each animal to 10 classical conditioning trials pairing the shock and the tone in an environment familiar to the animal. She then reintroduces the animal to a novel environment and examines the proportion of time the animal freezes following the presentation of the tone. Thus she has two variables for each animal, the proportion of time frozen in response to the tone before the conditioning trials and the proportion of time frozen in response to the tone following the conditioning trials.

To analyze these data, she computes a difference score, subtracting the proportion frozen prior to conditioning from the proportion frozen following conditioning. She believes that the mean value of this difference ought to be significantly greater than zero.

The actual mean value for the difference is 0.12 and its variance is .06.

1. Test the null hypothesis that the mean difference is equal to zero. (Provide Pre and F*).

2. She notices that older animals show a larger difference in the proportion of time frozen than younger animals. When she computes the correlation between the animal's age and the proportion difference, it equals .40. What would be the Pre and F* values if she were to retest her null hypothesis (as in #1 above), putting age into mean deviation form and controlling for it?

3. Assume that she plans to redo this study with 30 animals. What is the approximate probability that she would reject the null hypothesis of zero difference, assuming the same effect size and assuming she did the test without controlling for age.

Problem C

As you are undoubtedly already aware, one should not believe everyone that one reads in textbooks. The following excerpt is from a textbook: Lunneborg, C.E. (1994). *Modeling experimental and observational data*. This otherwise excellent textbook, which also uses a modeling approach as in Judd & McClelland (1989), contains an error in this section on polynomial regression. Interestingly, we also made the same error when we first drafted our textbook. But having read Judd & McClelland (1989, Chpt 10), you should be able to identify the error in the following excerpt.

1. Write a *short* memo to Lunneborg explaining the error and the correction you would suggest.

13.5
Polynomial Regression: Internal Measured Moderation

In Chapter 10, we described the inclusion in a model of the square of an x-variable or, on rare occasions, the cube when the influence relation is nonlinear. When we include such higher-order terms, we describe the models as polynomial.

Now, polynomial regression—certainly *quadratic regression*—can be thought of as moderated regression where the moderator variable is identical to the moderated explanatory variable.

In particular, the quadratic model

$$\mu(y \mid x = x_i) = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 \quad \textbf{(13.18)}$$

with its regression slope for a squared term can be written equally well in the form

$$\mu(y \mid x = x_i) = \beta_0 + [\beta_1 + \beta_2 x_i]x_i. \quad \textbf{(13.19)}$$

The single regression "slope", $[\beta_1 + \beta_2 x_i]$, describes again the expected change in y associated with a unit change in x. However, this amount is not constant; the regression is nonlinear.

As with moderated regression, reporting selected values of $[\widehat{\beta}_1 + \widehat{\beta}_2 x_i]$ ought to contribute to a better understanding of how a change in the value of the x-variable influences the mean of the y-variable than any attempt to report and interpret $\widehat{\beta}_1$ and $\widehat{\beta}_2$ separately.

Problem D

Five hundred white American adults residing in the state of Colorado were surveyed in order to examine predictors of prejudice towards Hispanic or Latino Americans expressed on standard questionnaire measures. For our purposes, four variables were measured:

PREJ	Responses to a multi-item measure of prejudice. Scores could range from 0 to 35. Higher scores indicate more explicit prejudice.
CONTACT	The percentage of students in the respondent's high school (when he or she went to high school) who were Hispanic or Latino.
AGE	Respondent's age at the time of the survey.
INCOME	Respondent's reported income (in thousands of dollars) at the time of the survey.

On the following pages are descriptive statistics for these four variables and their bivariate correlations. Additionally multiple regressions were conducted examining predictors of PREJ. In some of these analyses the following additional variables were defined and used as predictors:

C2	CONTACT *CONTACT
A2	AGE * AGE
CA	CONTACT * AGE
CA2	CONTACT * AGE * AGE

Based on these analyses, answer the following questions. Report the value of either Pre or F* where appropriate.

1. Is there a significant simple relationship between PREJ and CONTACT? If so, give us a one sentence five-o'clock news summary about it.

2. Is CONTACT a useful predictor of PREJ once we control for AGE of respondent? Explain substantively why the answer to this question is different from the answer to the first question.

3. Are INCOME and CONTACT useful as a set of predictors over and above AGE?

4. Using the model where PREJ is regressed on CONTACT and AGE, what is the predicted level of PREJ for someone of the average AGE in the sample but having zero contact with Hispanics while in high school?

5. Is there reason to think that the relationship between AGE and PREJ is nonlinear, controlling for INCOME and CONTACT?

6. Provide short interpretations for all slope coefficients in Model 6.

7. Since CONTACT with Hispanics in high school is obviously a more distant experience for older respondents, is there reason to think that the amount of CONTACT has less impact on PREJ for older respondents than for younger ones (controlling for INCOME)?

8. Is there reason to think that the relationship between AGE and PREJ is nonlinear, once we control for INCOME, CONTACT, and the AGE by CONTACT interaction? Explain any inconsistency between your answer to this question and the one you gave in response to question 5.

9. Suppose model 8 (with INCOME, CONTACT, AGE, CA, and A2 as predictors) were re-estimated, having put AGE in mean deviation form. Which of the five slopes in the model would change values? What would the new values be?

10. Is there any evidence to suggest that the nonlinear effect of AGE increases with higher levels of contact.

11. Write a five o'clock news summary that presents what these data have to tell us about the relationship between AGE, CONTACT, and PREJ, controlling for INCOME.

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Correlation Analysis

   4 'VAR' Variables:  AGE      CONTACT  INCOME   PREJ
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Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
AGE	500	47.06800	9.14432	23534	23.00000	67.00000
CONTACT	500	15.08000	11.01837	7540	0	55.00000
INCOME	500	50.56800	11.41920	25284	21.00000	85.00000
PREJ	500	13.99195	3.25355	6996	3.97330	22.15307

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 500

	AGE	CONTACT	INCOME	PREJ
AGE	1.00000	-0.27616	0.30518	0.40936
	0.0	0.0001	0.0001	0.0001
CONTACT	-0.27616	1.00000	0.00550	-0.13556
	0.0001	0.0	0.9024	0.0024
INCOME	0.30518	0.00550	1.00000	0.15701
	0.0001	0.9024	0.0	0.0004
PREJ	0.40936	-0.13556	0.15701	1.00000
	0.0001	0.0024	0.0004	0.0

Model: MODEL1
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	2	888.07085	444.03543	50.223	0.0001
Error	497	4394.12208	8.84129		
C Total	499	5282.19293			

Root MSE	2.97343	R-square	0.1681
Dep Mean	13.99195	Adj R-sq	0.1648
C.V.	21.25102		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	7.357646	0.79776087	9.223	0.0001
AGE	1	0.143257	0.01514547	9.459	0.0001
CONTACT	1	-0.007195	0.01256947	-0.572	0.5673

Model: MODEL2
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	2	891.16760	445.58380	50.434	0.0001
Error	497	4391.02533	8.83506		
C Total	499	5282.19293			

Root MSE	2.97238	R-square	0.1687
Dep Mean	13.99195	Adj R-sq	0.1654
C.V.	21.24353		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	6.807602	0.80385316	8.469	0.0001
AGE	1	0.141810	0.01528029	9.281	0.0001
INCOME	1	0.010078	0.01223622	0.824	0.4105

Model: MODEL3
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	2	228.52202	114.26101	11.237	0.0001
Error	497	5053.67091	10.16835		
C Total	499	5282.19293			

Root MSE	3.18879	R-square	0.0433
Dep Mean	13.99195	Adj R-sq	0.0394
C.V.	22.79015		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	12.326507	0.67584422	18.239	0.0001
INCOME	1	0.044948	0.01250103	3.596	0.0004
CONTACT	1	-0.040284	0.01295580	-3.109	0.0020

Model: MODEL4
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	3	894.97621	298.32540	33.727	0.0001
Error	496	4387.21672	8.84519		
C Total	499	5282.19293			

Root MSE	2.97409	R-square	0.1694
Dep Mean	13.99195	Adj R-sq	0.1644
C.V.	21.25571		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	7.036610	0.87676678	8.026	0.0001
INCOME	1	0.010870	0.01230257	0.884	0.3774
CONTACT	1	-0.008290	0.01263317	-0.656	0.5120
AGE	1	0.138750	0.01598454	8.680	0.0001

Model: MODEL5
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	4	907.23835	226.80959	25.662	0.0001
Error	495	4374.95458	8.83829		
C Total	499	5282.19293			

Root MSE	2.97293	R-square	0.1718
Dep Mean	13.99195	Adj R-sq	0.1651
C.V.	21.24741		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	6.870721	0.88766855	7.740	0.0001
INCOME	1	0.010320	0.01230664	0.839	0.4021
CONTACT	1	0.028274	0.03351238	0.844	0.3993
AGE	1	0.138956	0.01597927	8.696	0.0001
C2	1	-0.001054	0.00089486	-1.178	0.2394

Model: MODEL6
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	4	1027.06504	256.76626	29.870	0.0001
Error	495	4255.12789	8.59622		
C Total	499	5282.19293			

Root MSE	2.93193	R-square	0.1944
Dep Mean	13.99195	Adj R-sq	0.1879
C.V.	20.95442		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-4.575156	3.08575671	-1.483	0.1388
INCOME	1	0.009194	0.01213572	0.758	0.4490
CONTACT	1	-0.003641	0.01251043	-0.291	0.7711
AGE	1	0.658553	0.13353800	4.932	0.0001
A2	1	-0.005585	0.00142484	-3.920	0.0001

Model: MODEL7
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	4	1252.30292	313.07573	38.456	0.0001
Error	495	4029.89000	8.14119		
C Total	499	5282.19293			

Root MSE	2.85328	R-square	0.2371
Dep Mean	13.99195	Adj R-sq	0.2309
C.V.	20.39228		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	13.542470	1.29301202	10.474	0.0001
INCOME	1	0.003862	0.01185014	0.326	0.7446
CONTACT	1	-0.377750	0.05706903	-6.619	0.0001
AGE	1	0.010654	0.02467818	0.432	0.6661
CA	1	0.007990	0.00120600	6.625	0.0001

Model: MODEL8
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	5	1253.43136	250.68627	30.739	0.0001
Error	494	4028.76156	8.15539		
C Total	499	5282.19293			

Root MSE	2.85576	R-square	0.2373
Dep Mean	13.99195	Adj R-sq	0.2296
C.V.	20.41006		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	11.997366	4.35068519	2.758	0.0060
INCOME	1	0.003942	0.01186241	0.332	0.7398
CONTACT	1	-0.363142	0.06931592	-5.239	0.0001
AGE	1	0.073600	0.17101289	0.430	0.6671
CA	1	0.007685	0.00145871	5.268	0.0001
A2	1	-0.000624	0.00167717	-0.372	0.7101

Model: MODEL9
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	1267.94338	211.32390	25.953	0.0001
Error	493	4014.24955	8.14249		
C Total	499	5282.19293			

Root MSE	2.85351	R-square	0.2400
Dep Mean	13.99195	Adj R-sq	0.2308
C.V.	20.39391		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	13.417557	4.47551267	2.998	0.0029
INCOME	1	0.003979	0.01185307	0.336	0.7373
CONTACT	1	-0.443430	0.09172750	-4.834	0.0001
AGE	1	0.034812	0.17333017	0.201	0.8409
C2	1	0.001247	0.00093439	1.335	0.1825
A2	1	-0.000347	0.00168865	-0.205	0.8374
CA	1	0.008481	0.00157465	5.386	0.0001

Model: MODEL10
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	1269.83991	211.63999	26.004	0.0001
Error	493	4012.35301	8.13865		
C Total	499	5282.19293			

Root MSE	2.85283	R-square	0.2404
Dep Mean	13.99195	Adj R-sq	0.2312
C.V.	20.38910		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	5.970360	6.07509038	0.983	0.3262
INCOME	1	0.003774	0.01185082	0.318	0.7503
CONTACT	1	-0.038062	0.23918734	-0.159	0.8736
AGE	1	0.335887	0.25160959	1.335	0.1825
A2	1	-0.003374	0.00256069	-1.317	0.1883
CA	1	-0.007142	0.01054368	-0.677	0.4985
CA2	1	0.000162	0.00011426	1.420	0.1563

Model: MODEL11
Dependent Variable: PREJ

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	1281.52458	183.07494	22.514	0.0001
Error	492	4000.66834	8.13144		
C Total	499	5282.19293			

Root MSE	2.85157	R-square	0.2426
Dep Mean	13.99195	Adj R-sq	0.2318
C.V.	20.38007		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	7.766924	6.25461248	1.242	0.2149
INCOME	1	0.003821	0.01184564	0.323	0.7471
CONTACT	1	-0.138289	0.25327963	-0.546	0.5853
AGE	1	0.278462	0.25601988	1.088	0.2773
A2	1	-0.002888	0.00259136	-1.115	0.2656
C2	1	0.001125	0.00093854	1.199	0.2312
CA	1	-0.005156	0.01066845	-0.483	0.6291
CA2	1	0.000148	0.00011480	1.292	0.1968

Answers

Problem A

1.

$C\!: Dep = \beta_0 + \varepsilon_i$

$A\!: Dep = \beta_0 + \beta_1 ADEN_i + \varepsilon_i$

2.

$C\!: Dep = \beta_0 + \beta_1 ADEN_i + \varepsilon_i$

$A\!: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 ADEN_i^2 + \varepsilon_i$

3.

$C\!: Dep = \beta_0 + \varepsilon_i$

$A\!: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 DIAZ_i + \varepsilon_i$

4.

$C\!: Dep = \beta_0 + \beta_1 ADEN_i + \varepsilon_i$

$A\!: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 DIAZ_i + \varepsilon_i$

β_2 would be negative

5.

$C\!: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 DIAZ_i + \varepsilon_i$

$A\!: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 DIAZ_i + \beta_3 ADEN_i * DIAZ_i + \varepsilon_i$

6.

$C\!: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 ADEN_i^2 + \beta_3 DIAZ_i + \varepsilon_i$

$$A\!: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 ADEN_i^2 + \beta_3 DIAZ_i + \beta_4 ADEN_i * DIAZ_i + \beta_5 ADEN_i * DIAZ_i^2 + \varepsilon_i$$

7.

$$C: Dep = \beta_0 + \beta_0 + \beta_1 ADEN_i + \beta_2 ADEN_i^2 + \beta_3 DIAZ_i + \beta_4 DIAZ_i^2$$
$$+ \beta_5 ADEN_i * DIAZ_i + \beta_6 ADEN_i * DIAZ_i^2 +$$
$$+ \beta_7 ADEN_i^2 * DIAZ_i + \varepsilon_i$$

$$A: Dep = \beta_0 + \beta_1 ADEN_i + \beta_2 ADEN_i^2 + \beta_3 DIAZ_i + \beta_4 DIAZ_i^2$$
$$+ \beta_5 ADEN_i * DIAZ_i + \beta_6 ADEN_i * DIAZ_i^2 +$$
$$+ \beta_7 ADEN_i^2 * DIAZ_i + \beta_8 ADEN_i^2 * DIAZ_i^2 + \varepsilon_i$$

Problem B

1.

$$n = 10, \ \bar{Y} = .12, \ s^2 = .06$$
$$SSE(A) = (n-1)s^2 = 9(.06) = .54$$
$$SSR = \sum (\hat{Y}_{iC} - \hat{Y}_{iA})^2 = 10(0 - .12)^2 = .144$$
$$SSE(C) = SSE(A) + SSR = .54 + .144 = .684$$
$$PRE = .144/.684 = .211, \ n.s.$$
$$F^*_{1,9} = .211/(1 - .211)/9 = 2.4, \ n.s.$$
or $F^*_{1,9} = SSR/MSE = .144/.06 = 2.4, n.s.$

Thus, there is no evidence that the mean difference of .12 differs from the null hypothesis of 0.

2.

$PRE = r^2 = .4^2 = .16$

For testing $\beta_1 = 0$ for *Age*:

$SSE(C) = .54$ (i.e., the $SSE(A)$ from #1 above)

$SSE(A) = (1 - PRE)SSE(C) = .16(.54) = .454$

For testing $\beta_0 = 0$ when controlling for *Age*:

$SSE(A) = .454$

$SSR = .144$

$SSE(C) = SSE(A) + SSR = .454 + .144 = .598$

$PRE = SSR / SSE(C) = .144/.598 = .241, \ n.s.$

$F^*_{1,8} = .241 / (1 - .241)/8 = 2.54, \ n.s.$

Thus, even though we have a bit more power, there is still no evidence that the mean difference of .12 differs from the null hypothesis of 0.

3.

$$\eta^2 = 1 - (1 - PRE)\left[\frac{n - PC}{n - PA}\right] = 1 - (1 - .211)\left[\frac{10}{9}\right] = .12$$

From the closest value in the power table (C.5 on p. A-90), the approximate power would be a bit greater than .42.

Problem C

Although Equations 13.18 and 13.19 are indeed algebraically equivalent, the bracketed "slope" in 13.19 is not actually the instantaneous slope at X_i. It is necessary to find the slope by taking the derivative with respect to X_i, using that as the slope, and then solving to find the "intercept" that would maintain the algebraic equivalence. Hence, the correct expression should be

$$\mu(y|x = x_i) = [\beta_0 - \beta_2 x_i^2] + [\beta_1 + 2\beta_2 x_i]x_i$$

Problem D

1. Yes; Pre = .018; p = .0024. As contact goes up there is a reliable decrease in prejudice.

2. No; F* (1, 497) = 0.327. Answer is different from that in 1 because here we are controlling for age, and age and contact are redundant with each other.

3.

$$\hat{Prej}_i = 7.04 + .01 Income - .01 Contact + .14 Age \qquad SSE(A) = 4387.22$$

$$\hat{Prej}_i = b_0 + b_1 Age \qquad SSE(C) = ??$$

To find the SSE of this model C, we use the fact that the correlation between Age and Prej equals .409. If we square this it equals the Pre for comparing a model A in which Prej is predicted by Age (i.e., model C above) with a single parameter simple model. The sum of squares for the single parameter simple model for Prej equals the variance of Prej times N-1.

In other words, if we compare the following two models:

Model A: $Prej_i = \beta_0 + \beta_1 Age + \varepsilon_i$

Model C: $Prej_i = \beta_0 + \varepsilon_i$

The Pre would be .409^2. The SSE for Model C is [(3.254)**2]*449 = 5282.21.
So the SSR equals 885.17. And the SSE for the model in which Prej is predicted by Age alone equals (5282.21 - 885.17) = 4397.04..

Accordingly, the SSR for comparing Model C that only uses Age as a predictor with Model A that uses Age plus Income and Contact equals 4397.04 - 4387.22. The Pre equals .002 which does not beat the critical value. So the answer is that Contact and Income are not useful as a set in predicting Prej over an above Age.

4. Predicted Prej = 7.358 + .143(47.068) = 14.09

5. Yes; F*(1,495) = (3.92)**2 = 15.37

6. .009: Slope for Income controlling for Contact, Age, and quadratic Age.
-.004 Slope for Contact controlling for Income, Age, and quadratic Age.
.659 Simple slope for Age when Age = 0, within levels of Contact and Income.
-.006 Half the change in the Age simple slope as Age increases, controlling for Income and Contact.

7. Yes; F*(1,495) = (6.625)**2 = 43.89.

8. No; F*(1,494) = (-.372)**2 = .138. Here we are controlling for the Contact by Age interaction whereas in question 5 we were not. So the increasing effect of Age on Prej at older Ages disappears once we control for the fact that Contact is less impactful for older respondents.

9. If Age were mean deviated in model 8, coefficients for both Contact and Age would change.

The new coefficient for Contact would equal (-.363 + .008(47.068)) = .014.
The new coefficient for Age would equal (.074 - (2)(.0006)(47.07)) = .044.

10. No; F*(1,493) = (1.420)**2 = 2.016.

11. As Age goes up, Prej goes up, even controlling for Income and Contact. Contact and Income are both reliably related to Prej, but not once we control for Age. Additionally, there is evidence that Age differences in Prej are greater at older Ages, but this effect disappears once we control for the fact that Contact has less impact on reducing Prej among older respondents. In sum, higher Age is associated with more Prej and Contact has less of an effect on reducing Prej among older respondents.