

Subject Variables

Challenges and Benefits

Memory and Attention

Last fall, an investigator was interested in the effects of time of day upon two types of cognitive performance tasks (a memory task and an attention task). Volunteer subjects were recruited by advertisements in the student newspaper. Volunteers were asked to call the lab and were then asked when they could participate. Times available were 8am, 12 noon, 4 pm, and 8pm. Upon their arrival at the lab, participants first did a choice reaction time task for 15 minutes and then spent 15 minutes doing a working memory task. Accuracy measures were taken for both tasks. 120 subjects participated

Attention, Memory, time of day

	8 am	12 noon	4 pm	8 pm
Choice % correct	95%	95%	95%	95%
Memory % recalled	80%	80%	80%	80%

Although there was no effect for time of day, the % correct for the attention task was greater than the % recalled for the memory task.

From this pattern of results, the investigator concluded that time of day does not effect cognitive performance, and that choice reaction time is easier than working memory.

Are these conclusions justified?

Attention, Memory, Time of Day

- This winter, another investigator was interested in the effects of time of day upon two types of cognitive performance tasks (a memory task and an attention task). Volunteer subjects were recruited by advertisements in the student newspaper. Volunteers were asked to call the lab and were then randomly assigned by blocks to one of 4 conditions. Times available were 8am, 12 noon, 4 pm, and 8pm.
- Upon their arrival at the lab, participants first did a choice reaction time task for 15 minutes and then spent 15 minutes doing a working memory task. Accuracy measures were taken for both tasks.
- Of the 120 subjects who volunteered and were assigned to the four conditions, 80 actually participated and the losses were uniform from the four cells of the design.

Attention, Memory, Time of Day

	8 am	12 noon	4 pm	8 pm
Choice % correct	90%	90%	90%	90%
Memory % recalled	70%	70%	70%	70%

Although there was no effect for time of day, the % correct for the attention task was greater than the % recalled for the memory task.

From this pattern of results, the investigator concluded that time of day does not affect cognitive performance, and that choice reaction time is easier than working memory. Are these conclusions justified

- In a reanalysis of the data from the first and second of these experiments, a meta-analyst noticed that the means were lower for the second study than the first, and also noticed that while the first study had been done in the fall, the second study had been done in the winter.

Attention, Memory, Season

Fall Data:

	8 am	12 noon	4 pm	8 pm
Choice % correct	95%	95%	95%	95%
Memory % recalled	80%	80%	80%	80%

Winter data:

	8 am	12 noon	4 pm	8 pm
Choice % correct	90%	90%	90%	90%
Memory % recalled	70%	70%	70%	70%

Attention, Memory, Season?

- This meta-analyst interpreted these data as showing seasonal effects rather than time of day effects and made the additional claim that seasonal effects have a greater impact upon memory than reaction time accuracy.
- Are these two conclusions justified?
- What is a plausible rival hypothesis?
- Design a study that would test this rival hypothesis.

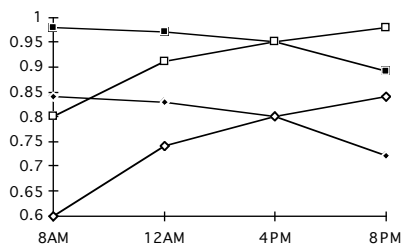
Attention, Memory, Personality?

- Yet another investigator became interested in these time of day data and decided to reanalyze the first two studies looking at possible personality variation in time of day and performance. High and low impulsivity was assessed by questionnaire given as part of another study. These reanalyzed data looked like this:

Attention, Memory, Personality

	8 am	12 noon	4 pm	8 pm
Low Imp	N=25	N=20	N=15	N=10
Choice % correct	98%	97%	95%	89%
Memory % recalled	84%	83%	80%	72%
High Imp	N=5	N=10	N=15	N=20
Choice % correct	80%	91%	95%	98%
Memory % recalled	60%	74%	80%	84%

Attention, Memory, Personality



Introversion/Extraversion and GRE Performance

- An experimenter was interested in the relationship between introversion-extraversion and intellectual ability. Introversion-extraversion was measured using the Eysenck Personality Inventory, and intellectual ability was measured using the Graduate Record Examination.
- For simplicity of presentation, Introversion-Extraversion (I-E) scores were divided into thirds: Introverts, Ambiverts, and Extraverts. All subjects were given the GRE in a relaxed setting and the following data were obtained:

I/E and GREs

Personality Group	GRE score
Introverts	550
Ambiverts	525
Extraverts	500

Noting that these means were significantly different, the investigator concluded that Introverts were more able than extraverts.

Is this conclusion justified?

What are some plausible alternative hypotheses?

GRE and Caffeine

Another investigator believed that motivational state affects cognitive performance. Motivational state was manipulated by caffeine and cognitive performance was assessed by GRE performance. 120 subjects were block randomly assigned to 3 conditions: 0 mg/kg of body weight of caffeine, 2 mg/kg, and 4 mg/kg of caffeine. Ability was assessed using the GRE.

Drug Condition	GRE score
0	525
2	525
4	525

From these data the investigator concluded that GRE performance was unaffected by motivational state.

Is this conclusion justified from the data?

I/E, Caffeine and GREs

Another investigator then used the same tests of I-E and GRE as the previous investigators, but administered placebo (0mg/kg) to one third of the subjects, 2m/kg and 4 mg/kg of caffeine to the other two thirds (block randomizing the caffeine dosage within personality groups). The data were

Personality Group	GRE SCORE		
	0 mg/kg	2 mg/kg	4mg/kg
Introverts	550	525	500
Ambiverts	525	525	525
Extraverts	500	525	550

Interactions vs. Main effects

- From these data, this investigator concluded that there was no ability difference between introverts and extraverts, and no main effect of caffeine upon performance, but rather a differential response to caffeine depending upon personality.
- How does this finding relate to the previous two results? Do these findings change the interpretation of the previous results?

Designs- the problems and benefits of subject variables

Subject variables as necessary in psychological studies

- a) if people do not differ on a variable, is it a psychological variable?
- b) subject variables are either part of theory or extraneous to theory

Subject variables as sources of variance

- Extraneous to theory
 - noise variance (unsystematic)
 - confounded variance (systematic)
- Part of theory

Controlling unsystematic Subject Variance

Within subject design controls for ability and motivational differences

Trait variables

ability
age
prior practice

State variables

prior practice
interest

Within Subjects Designs- Problems

order, fatigue, practice

Controlled by counterbalancing

(if the effects are linear)

Counterbalancing does not protect against differential transfer (Learn more in one condition than the other)

Counterbalancing and fatigue

Trial	Linear Fatigue	Accelerating Fatigue
1 A	0	0
2 B	10	10
3 B	20	20
4 A	30	40
Mean A	15	20
Mean B	15	15

Subject variables as systematic sources of variance

Subject attrition
Subject volunteer effects
Subject by task interactions
Subject by manipulation interactions

Subject variables as sources of theoretical variation

- Developmental Trends
- Effect of ability
- Effect of motivation
- Individual differences in general

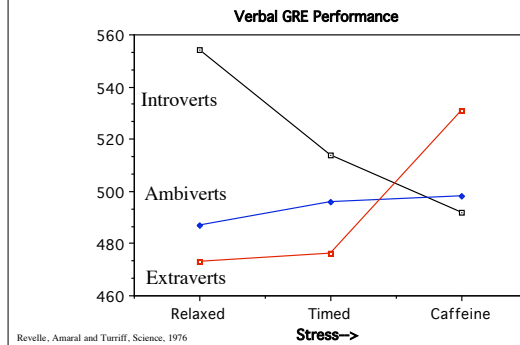
Individual differences and interactions

- Main effects of individual differences are hard to interpret
 - Measure X and Y
 - Subjects with X do better than subjects with Y
 - Do X subjects do better because they are
 - More motivated
 - Smarter
 - More resistant to fatigue
 - More practiced

Example of Extraversion

- Arousal theory
 - Assumptions
 - Introverts are more aroused than extraverts
 - Caffeine increases arousal
 - arousal has a curvilinear relationship to performance
 - Predictions
 - Introverts should be helped less (hurt more) by caffeine than extraverts

Introversion, time pressure, and caffeine: effect on verbal performance



Problems with design

- Drug dosage was not by body weight
- Are introverts less used to caffeine than extraverts -- is it a caffeine arousal effect or is it a familiarity effect?
- Can it be replicated?

Extraversion, Caffeine, and Cognitive Performance

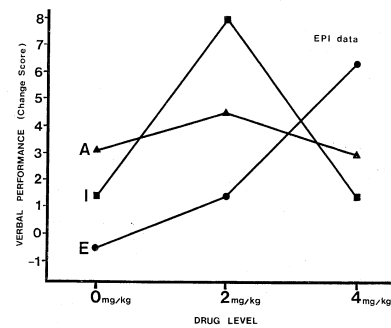
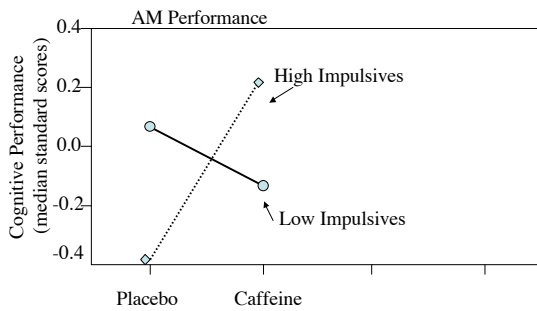
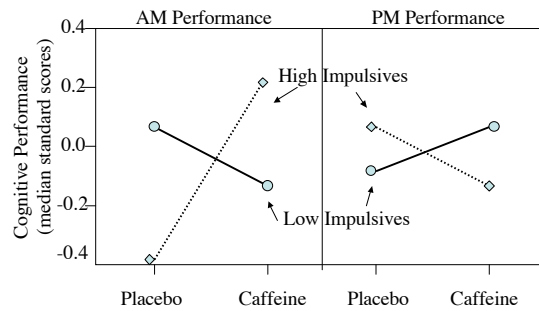


Figure 9. EPI based group means for change in number of items correctly answered on GRE practice tests.

Impulsivity, Caffeine, and Time of Day: the effect on complex cognitive performance



Impulsivity, Caffeine, and Time of Day: the effect on complex cognitive performance



Advantages of interactions: the case of extraversion

- By making the effect disappear or reverse, we can eliminate certain alternative explanations
- Effect can not be due to differential ability
- Can not be due to differential sensitivity to caffeine
- Have disproved hypothesis of stable difference in arousal