Psychology 205: Research Methods in Psychology
Subject Variables in Psychological Research
Challenges and Benefits

William Revelle

Department of Psychology
Northwestern University
Evanston, Illinois USA

October, 2015

Outline

Memory and Attention

1. 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).
2. 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.
3. 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.
4. Accuracy measures were taken for both tasks.
5. 120 subjects participated

Attention, Memory, Time of Day

Table : Attention, memory, and 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, and Time of Day

1. 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).
2. Volunteer subjects were recruited by advertisements in the student newspaper.
3. Volunteers were asked to call the lab and were then randomly assigned by blocks to one of 4 conditions.
4. Times available were 8am, 12 noon, 4 pm, and 8pm.
5. 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.
6. 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, and Time of Day

Table : Attention, memory, and 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 effect cognitive performance, and that choice reaction time is easier than working memory.

Are these conclusions justified?

a meta analysis of Study 1 and 2

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.

Table : Attention, memory, and time of day

	8 am	12 noon	4 pm	8 pm
Fall				
Choice % correct	95%	95%	95%	95%
Memory % recalled	80%	80%	80%	80%
Winter				
Choice % correct	90%	90%	90%	90%
Memory % recalled	70%	70%	70%	70%

Meta analysis of studies 1 and 2

Table : Attention, memory, and time of day

	8 am	12 noon	4 pm	8 pm
Fall				
Choice % correct	95%	95%	95%	95%
Memory % recalled	80%	80%	80%	80%
Winter				
Choice % correct	90%	90%	90%	90%
Memory % recalled	70%	70%	70%	70%

1. 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.
2. Are these two conclusions justified?
3. What is a plausible rival hypothesis?
4. Design a study that would test this rival hypothesis.

Impulsivity and time of day

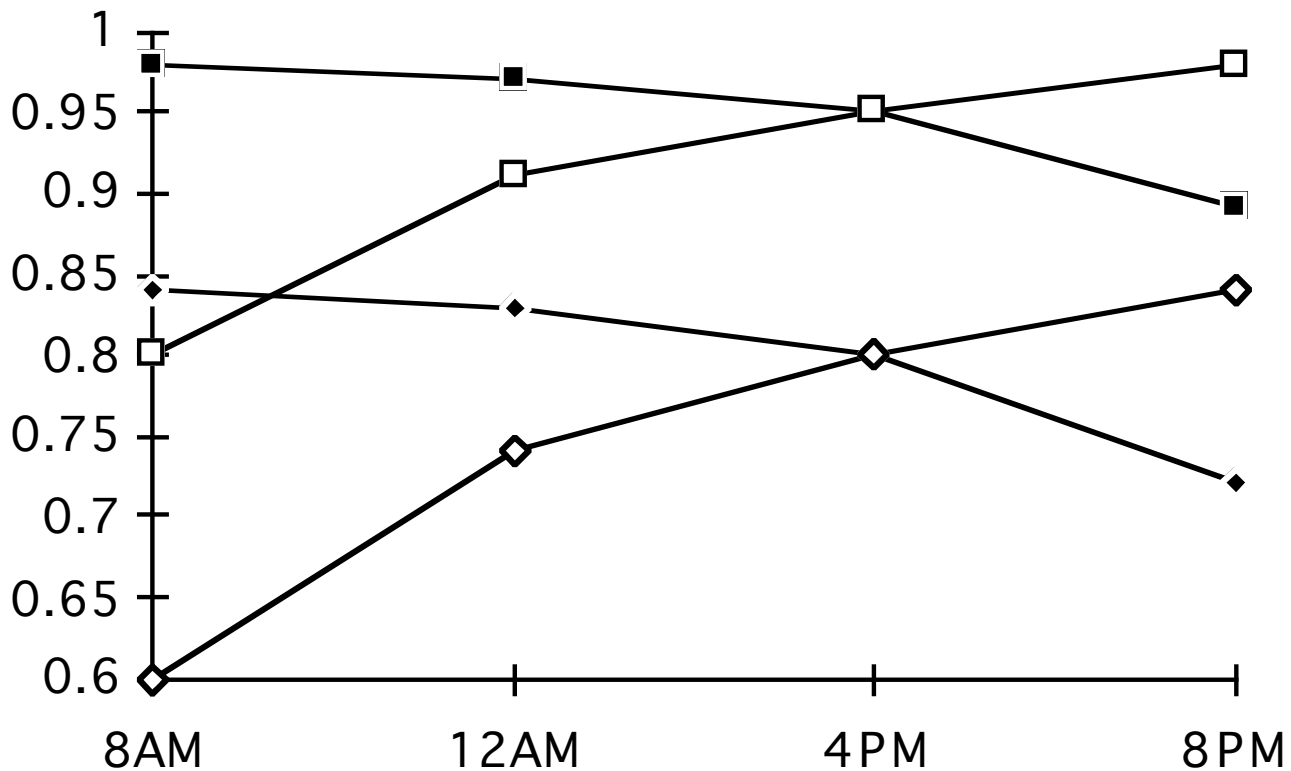
1. Yet another investigator became interested in these time of day data and decided to reanalyze the first two studies looking at possible personality variation in time of day and performance.
2. High and low impulsivity was assessed by questionnaire given as part of another study.

Table : These reanalyzed data looked like this:

	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%	90%
Memory % recalled	60%	740%	80%	84%

Personality by time of day for two cognitive tasks

Attention, Memory, Personality



GRE performance by Introversion/extraversion

1. An experimenter was interested in the relationship between introversion-extraversion and intellectual ability.
    - Introversion-extraversion was measured using the Eysenck Personality Inventory
    - intellectual ability was measured using the Graduate Record Examination
2. 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:
        - Introverts 550
        - Ambiverts 525
        - Extraverts 500
3. Noting that the means were significantly different, the investigater concluded that the introverts were more able than the extraverts. Is this conclusion justified?

GRE and Caffeine

1. Another investigator believed that motivational state affects cognitive performance.
   - Motivational state (arousal) was manipulated by caffeine
   - Cognitive performance was assessed by GRE performance
2. 120 subjects were block randomized into 3 conditions (0 mg caffeine per kg of body weight, 2 mg/kg and 4 mg/kg.
3. The data
   - 0 mg/kg 525
   - 2 mg/kg 525
   - 4 mg/kg 525
4. From these data the investigator concluded that GRE performance was unaffected by motivational state.
5. Is this conclusion justified by these data?

I/E, caffeine, and GREs

1. Another investigator then used the same tests of I-E and GRE as the previous investigators, but administered placebo (0 mg/kg) to one third of the subjects, 2 mg/kg to another third, and 4 mg/kg of caffeine to the third group.
2. Caffeine was block randomly assigned within each personality group.

Table : Personality, Caffeine, and GRE performance

Personality group	GRE Score			
	0 mg/kg	2 mg/kg	4 mg/kg	Average
Introverts	550	525	500	525
Ambiverts	525	525	525	525
Extraverts	500	525	550	525
Average	525	525	525	

Interactions and main effects

1. 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.
2. 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

1. Subject variables as necessary in psychological studies
   - if people do not differ on a variable, is it a psychological variable?
   - subject variables are either part of theory or extraneous to theory
2. Extraneous to theory
   - noise variance (unsystematic)
   - confounded variance (systematic)
3. Part of Theory

Controlling unsystematic Subject Variance

1. Within subject design controls for ability and motivational differences
2. Trait variables are stable within subject across time
   - ability
   - age
   - prior practice
   - anxiety (trait)
3. State variables are ways subjects differ at the moment
   - prior practice
   - interest
   - fatigue
   - anxiety (state)

The standard problems of within subject designs

1. order, fatigue, practice
   - Controlled by counterbalancing
   - if the effects are linear
2. Counterbalancing does not protect against differential transfer
   - (Learn more in one condition than the other)

Subject variables as systematic sources of variance

1. Subject attrition
   - Who drops out?
   - Why do they drop out?
2. Subject volunteer effects
   - Who volunteers
   - Interested, conscientious
3. Subject by task interactions
4. Subject by manipulation interactions
   - stress by personality

Subject variables as sources of theoretical variation

1. Developmental Trends
2. Effect of ability
3. Effect of motivation
4. Individual differences in general

Individual differences and interactions

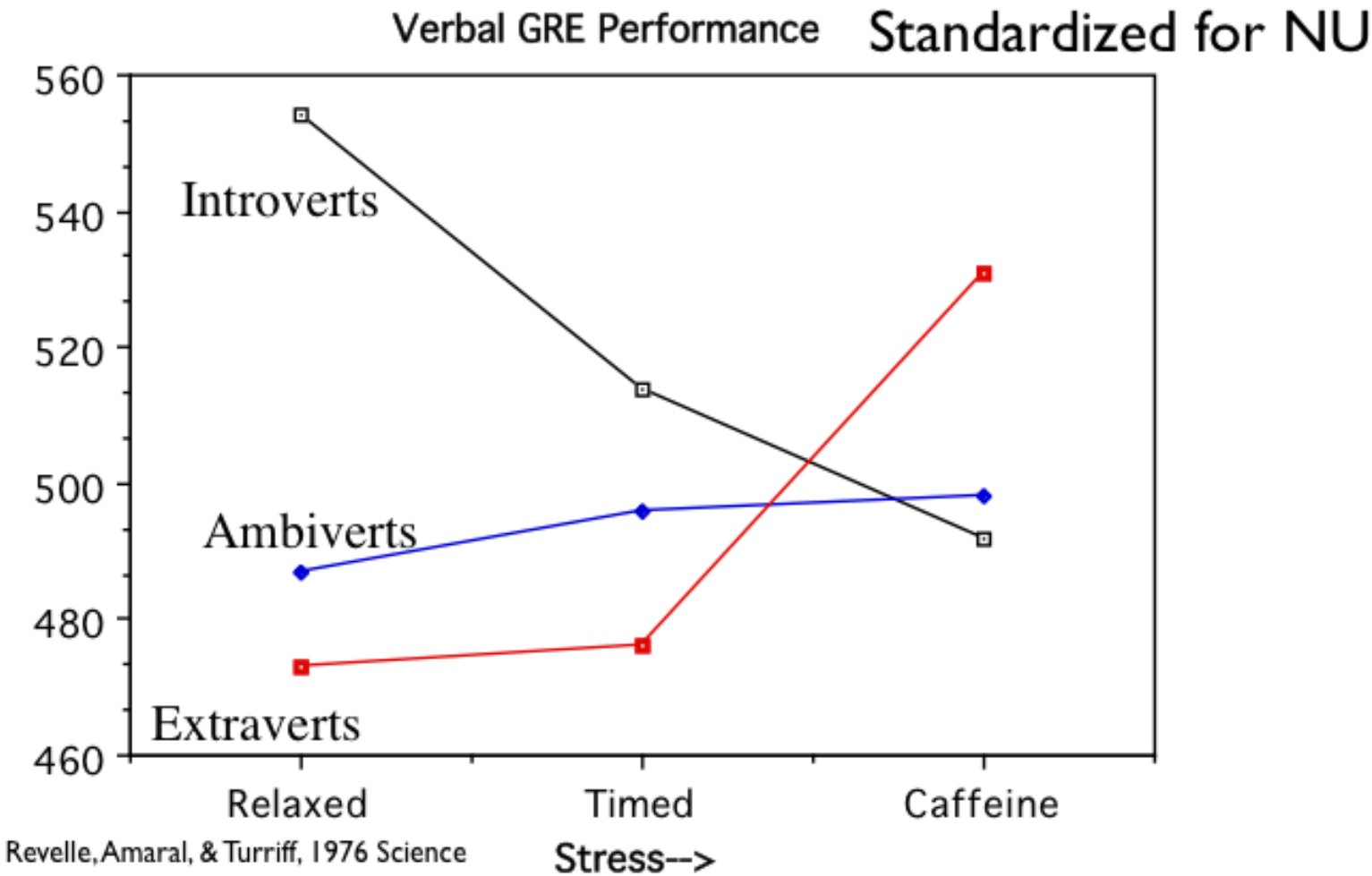
1. Main effects of individual differences are hard to interpret
   - Measure X and x
   - Subjects with X do better than subjects with x
2. Do X subjects do better because they are
   - More motivated
   - More able
   - More resistant to fatigue
   - More practiced

Example of Extraversion

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

Introversion-extraversion, time stress and caffeine

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



Problem with design

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

No – the Gilliland EPQ data set

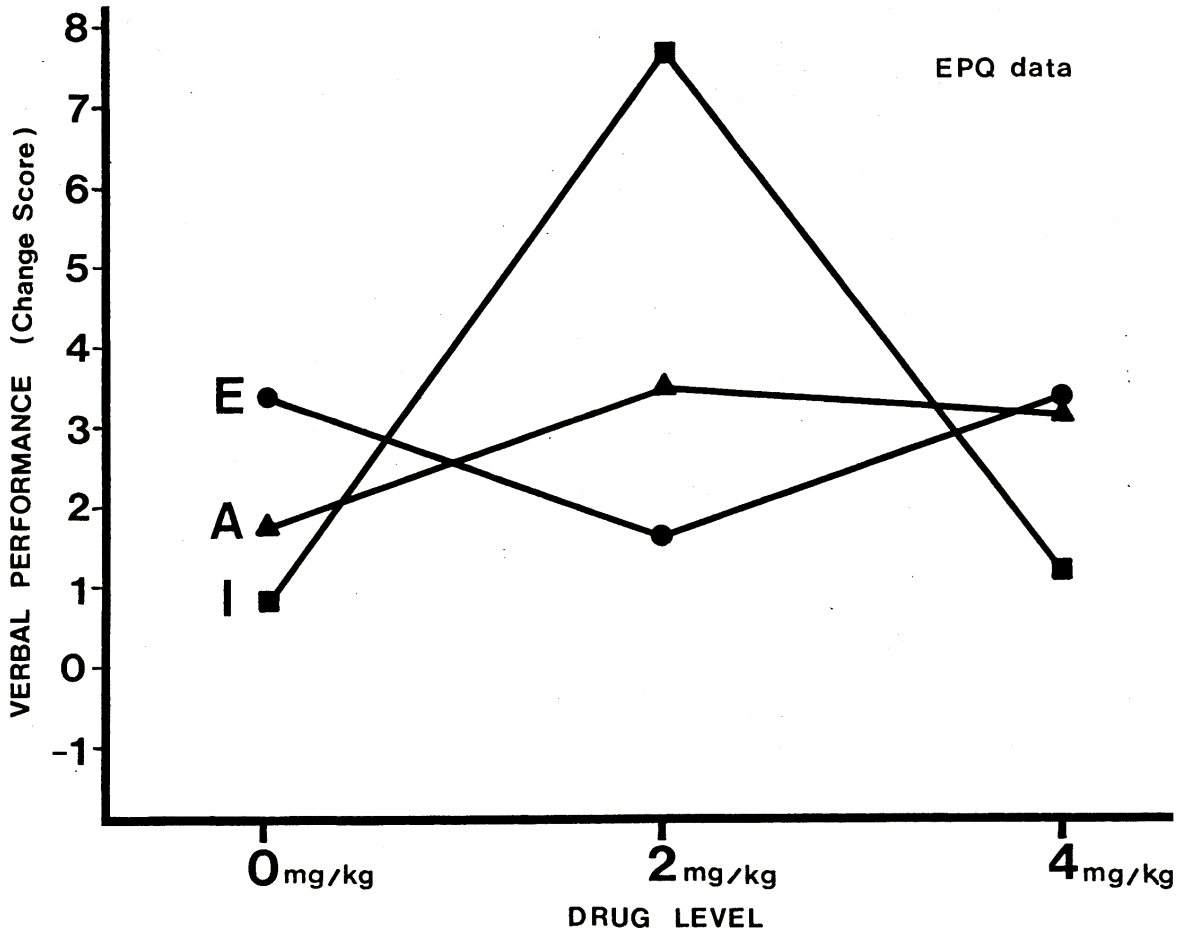
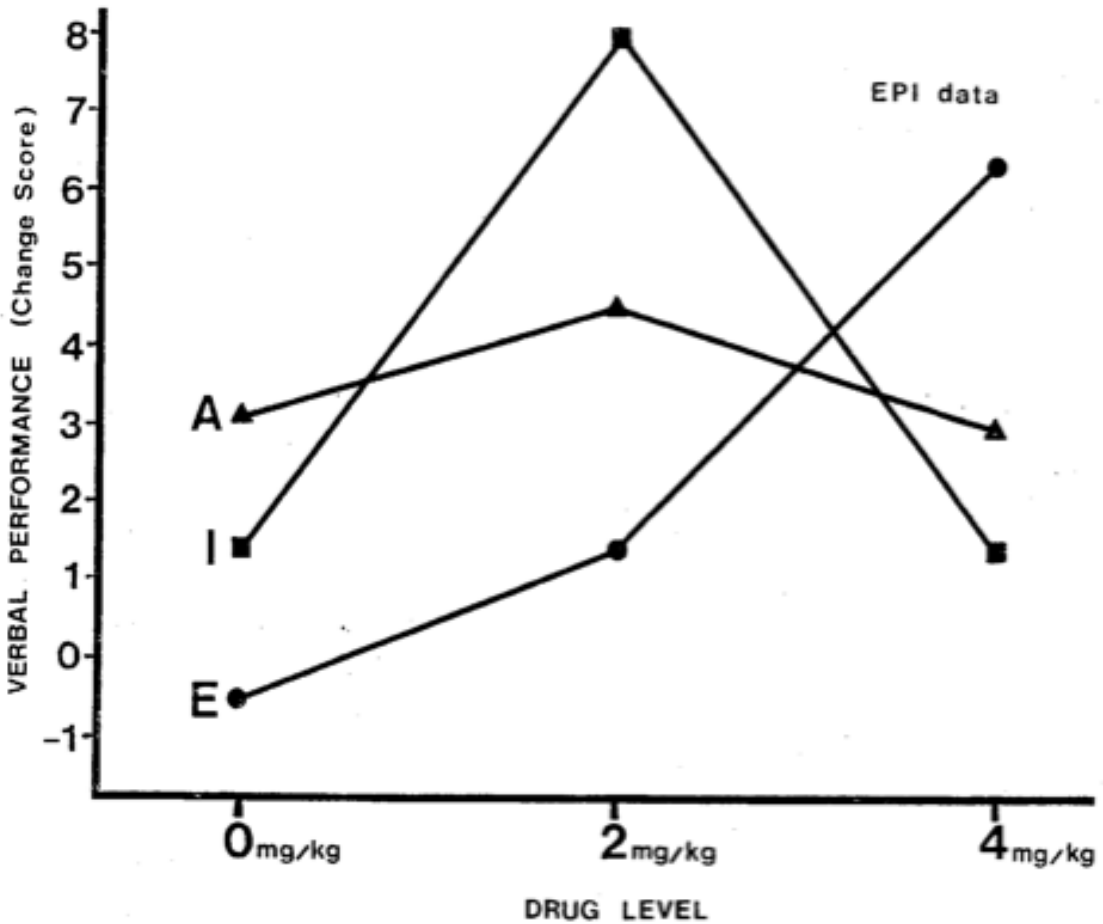


Figure 8. EPQ based group means for change in number of items correctly answered on GRE practice tests.

26

Yes – The Gilliland EPI data set

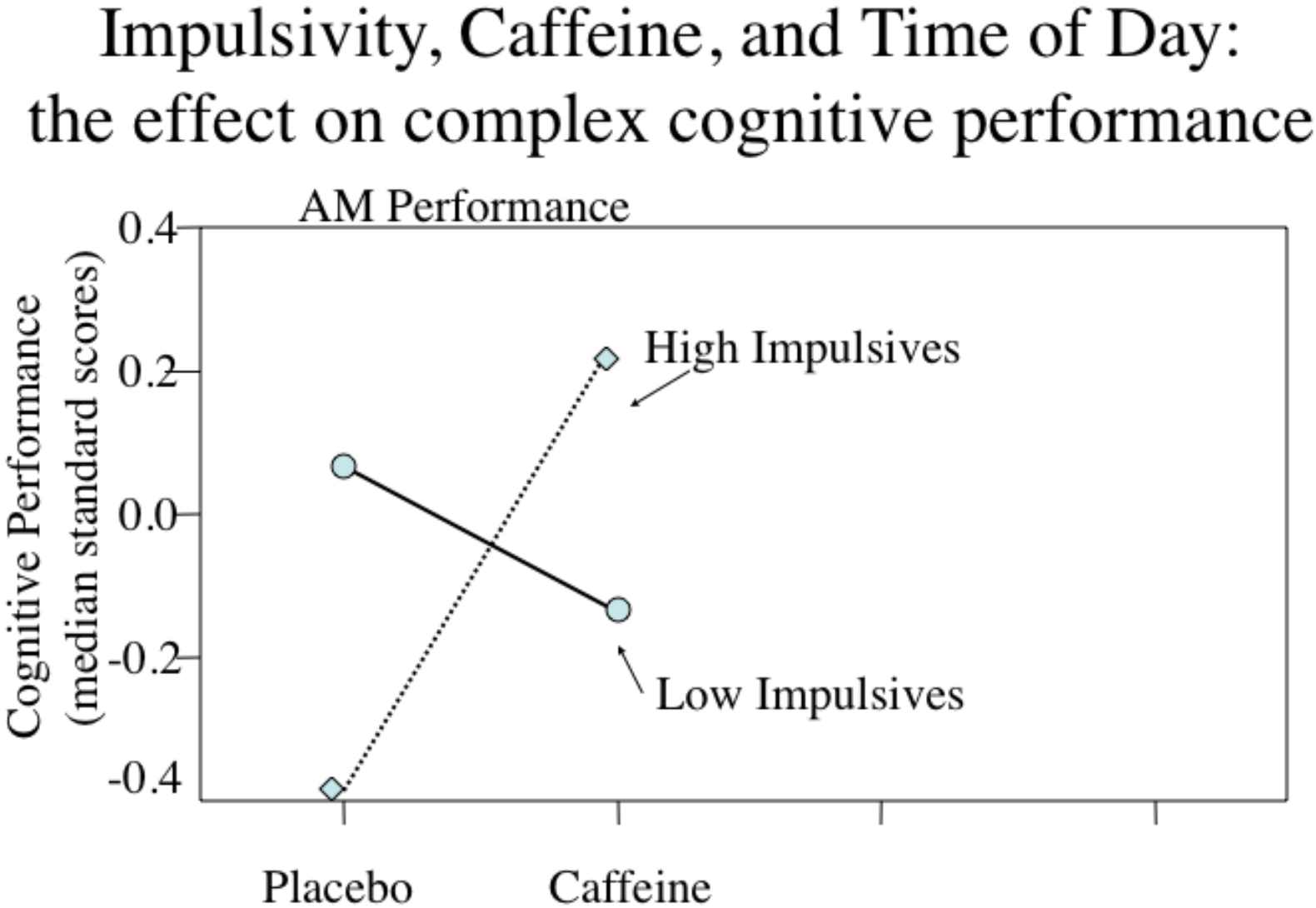
Extraversion, Caffeine, and Cognitive Performance



Gilliland, 1976

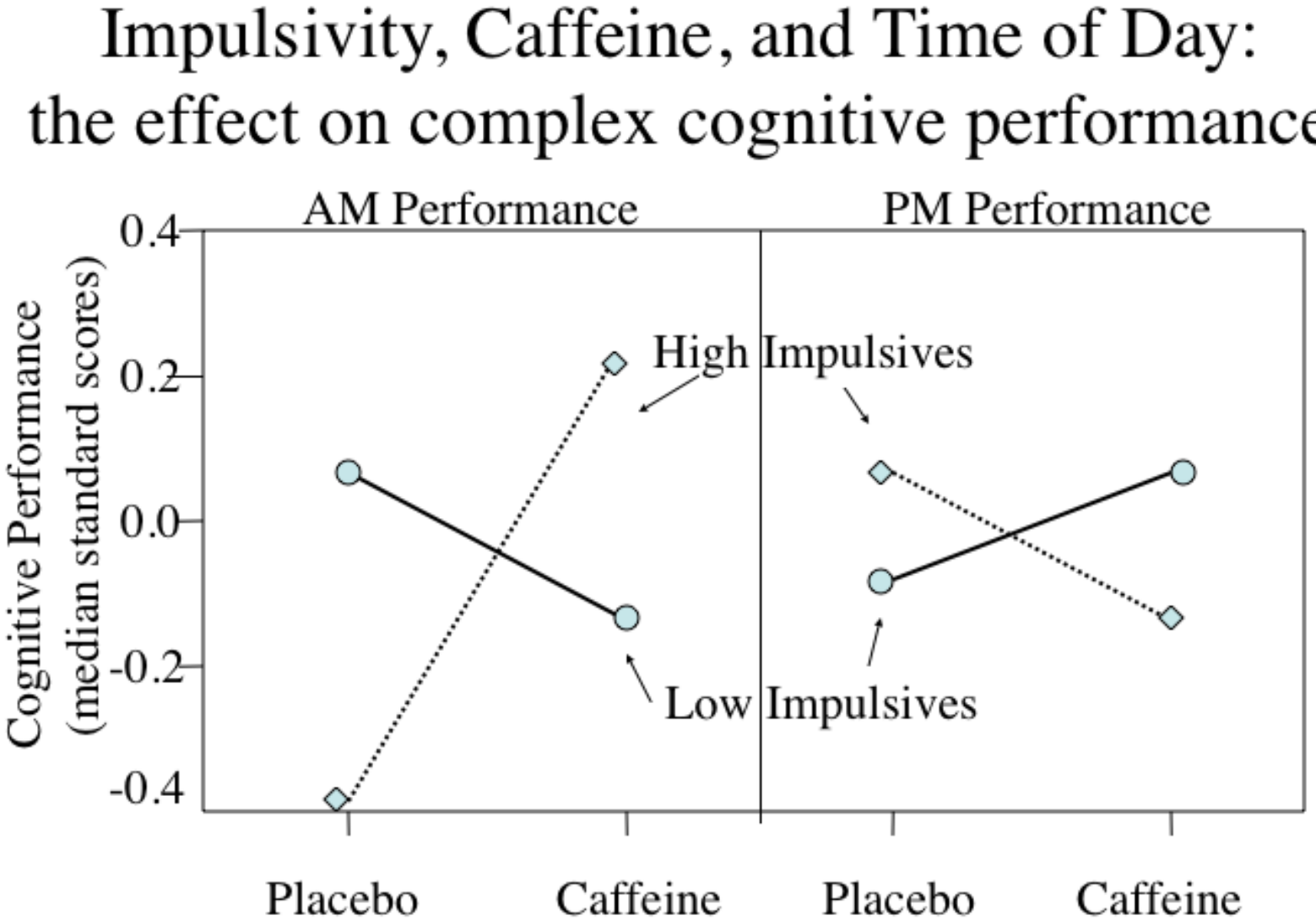
Figure 9. EPI based group means for change in number of items correctly answered on GRE practice tests.

Impulsivity and Cognitive Performance



Revelle, Humphreys, Simon and Gilliland, JEP:G, 1980

Impulsivity and Cognitive Performance – The effect of time of day



Revelle, Humphreys, Simon and Gilliland, JEP:G, 1980

Advantages of interactions: the case of extraversion

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