Melancholic (NI)  Choleric (NE)
Phlegmatic (SI)  Sanguine (SE)
Two dimensions of personality
Introversion Extraversion

• Simple Descriptive Basis
  – Self reports
    • Sociable
    • Active
    • Impulsive
    • Spontaneous

• Peer ratings correlate with self reports
  – People who describe themselves as outgoing are more known to others
Defining items from IPIP

• Am skilled in handling social situations.
• Am the life of the party.
• Don't mind being the center of attention.
• Know how to captivate people.
• Start conversations.
• Feel comfortable around people.
• Make friends easily.
• Cheer people up.
• Warm up quickly to others.
• Talk to a lot of different people at parties.

• Don't talk a lot.
• Retreat from others.
• Am hard to get to know.
• Avoid contacts with others.
• Don't like to draw attention to myself.
• Have little to say.
• Keep in the background.
• Find it difficult to approach others.
• Would describe my experiences as somewhat dull.
• Keep others at a distance.
Obvious behavioral correlates

• E’s talk more
  – But this interacts with group size
  – More well known

• Occupational differences
  – Extraversion and success in sales
    (but is this ambition or sociability?)

• Introversion and preference for isolation
Obvious behavioral correlates (continued)

- Extraversion and stimulation seeking
  - Higher risk of arrest
    - (interacts with social class)
  - Higher risk of auto accidents
- Greater sexual activity
  - E’s have
    - More partners
    - Earlier onset
    - Prefer more positions
Theoretical - Causal basis
Does I/E have a biological basis?

- Contributions of Hans Eysenck and his collaborators as an example of programmatic research in personality
  - Eysenck attempted to unite experimental and individual differences psychology
  - Attempted to apply best current theory to the study of individual differences
  - I-E research as an example of programmatic research
    - More recent work on I/E has not been as programmatic
I-E Early work

• Differences in conditionability
  – Original hypothesis
    • Introverts are easily conditioned
    • Introverts become well socialized
  – Later findings
    • Conditioning differences depend upon situation
    • Low arousal situations lead to better conditioning for introverts
    • Impulsivity more important than extraversion
      (Levy and Eysenck, 1972)
I-E and conditioning

- Newman’s work on psychopaths and conditioning
  - ability to stop
- Gray’s model of anxiety, impulsivity and conditioning (reinforcement sensitivity)
- Zinbarg
  - Sensitivity to cues of reward and action (impulsivity)
  - Sensitivity to cues of punishment and inaction (anxiety)
- Gray’s revised model of Reinforcement Sensitivity Theory
  - Gray and McNaughton (2000); Corr (in press)
Gray’s original hypothesis

Sensitivity for Cues for Reward

Sensitivity for Cues for Punishment

Introverts

Extraverts

Anxious

Neurotic

Impulsive

Non-impulsive

Stable

Non-anxious
Hypothesis of arousal differences

• What is arousal?
  – Arousal of the hand, the heart, and the head
    • Skin conductance
    • Heart rate
    • EEG desynchronization
  – Self reports (Robert Thayer, Gerry Matthews)
    • Energetic arousal
    • Tense arousal
Representative MSQ items
(arranged by angular location)

<table>
<thead>
<tr>
<th>Item</th>
<th>EA-PA</th>
<th>TA-NA</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>energetic</td>
<td>0.8</td>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>elated</td>
<td>0.7</td>
<td>0.0</td>
<td>2</td>
</tr>
<tr>
<td>excited</td>
<td>0.8</td>
<td>0.1</td>
<td>6</td>
</tr>
<tr>
<td>anxious</td>
<td>0.2</td>
<td>0.6</td>
<td>70</td>
</tr>
<tr>
<td>tense</td>
<td>0.1</td>
<td>0.7</td>
<td>85</td>
</tr>
<tr>
<td>distressed</td>
<td>0.0</td>
<td>0.8</td>
<td>93</td>
</tr>
<tr>
<td>frustrated</td>
<td>-0.1</td>
<td>0.8</td>
<td>98</td>
</tr>
<tr>
<td>sad</td>
<td>-0.1</td>
<td>0.7</td>
<td>101</td>
</tr>
<tr>
<td>irritable</td>
<td>-0.3</td>
<td>0.6</td>
<td>114</td>
</tr>
<tr>
<td>sleepy</td>
<td>-0.5</td>
<td>0.1</td>
<td>164</td>
</tr>
<tr>
<td>tired</td>
<td>-0.5</td>
<td>0.2</td>
<td>164</td>
</tr>
<tr>
<td>inactive</td>
<td>-0.5</td>
<td>0.0</td>
<td>177</td>
</tr>
<tr>
<td>calm</td>
<td>0.2</td>
<td>-0.4</td>
<td>298</td>
</tr>
<tr>
<td>relaxed</td>
<td>0.4</td>
<td>-0.5</td>
<td>307</td>
</tr>
<tr>
<td>at ease</td>
<td>0.4</td>
<td>-0.5</td>
<td>312</td>
</tr>
<tr>
<td>attentive</td>
<td>0.7</td>
<td>0.0</td>
<td>357</td>
</tr>
<tr>
<td>enthusiastic</td>
<td>0.8</td>
<td>0.0</td>
<td>358</td>
</tr>
<tr>
<td>lively</td>
<td>0.9</td>
<td>0.0</td>
<td>360</td>
</tr>
</tbody>
</table>
Basal arousal differences

• Detected in psychophysiological experiments
  – (see Stelmack, 1990 for a review)
  – Electrophysiology (EEG)
    • Now you see it, now you don’t
    • Gale, 1981
    • Gale and Coles suggestion conditions need to be just right
Basal arousal differences

- Sedation threshold
  - Shagass (1955), Claridge et al. (1981)

- Skin Conductance
  - Revelle (1973)

- Spontaneous GSR
  - Crider and Lunn (1971)

- Photic Driving
  - Robinson (1982)
Sedation Threshold
C. Shagass (1955)

Fig. 1. Illustrates effect of Sodium Amytal on bifrontal EEG. Note progressive increase of the fast-frequency amplitude. Arrow points to inflection point in the amplitude curve which indicates sedation threshold.
Threshold differences detected by psychophysical methods

• Light Sensitivity (threshold)
  – Siddle (1967)  staircase method

• Sound sensitivity
  – Smith (1968)  forced choice

• Pain sensitivity
  – Haslam (1967)
  – Petrie (1960)

• Bi-modal sensitivity
  – Shigehisa and Symons (1973)

• Reaction to lemon juice
  – Eysenck, 1967
Body temperature and time of day

• Blake (1967) was cited as showing biological differences related to arousal but how relevant is this to basic theory?
• Folkard (1976)
• Eysenck and Folkard (1980)
• Wilson (1990)
Body Temperature as $f(\text{time of day})$
(Baehr, Revelle & Eastman, 2000)
Morningness/Eveningness and BT

![Graph showing temperature variations over time for M-types and E-types.]

Temperature (°C)

Time (hours)

16:00 20:00 00:00 04:00 08:00 12:00 16:00

M-types

E-types

|| = Average Sleep

|| = Average $T_{MIN}$
Is it level, or rates of change?

- Vigilance decrements from sleep deprivation similar to that of extraverts
- Do stimuli lose arousing properties faster for extraverts/high impulsives?
- Habituation of orienting response
- Bowyer, Humphreys and Revelle suggested that the effect was a decay rate in arousal
- But Anderson and Revelle show interaction with Time of Day
Behavioral Consequences of arousal differences

• Differences in Arousal preference
  – Wundt’s curvilinear hypotheses
    • Moderate levels of arousal are more pleasing than extreme levels
    • (“the Goldilocks hypothesis”)
  – Berlyne
    • Changes in arousal are more pleasing than a steady state
    • Increases or decreases are pleasant
Wundt’s hedonic curve
(adapted from Berlyne)

Arousal potential ->

Hedonic tone ->

Pleasant

Boring

Frightening

Arousal potential ->
Berlyne’s hedonic curve
(adapted from Berlyne)

Arousal potential ->

Hedonic tone ->

Calming

Exciting

Adaptation to Current State

Boring

Frightening

Arousal potential ->
Wundt’s hedonic curve + Individual Differences
(adapted from Eysenck)

Arousal potential of situation ->

Hedonic tone ->

Introverts

Pleasant

Extraverts

Boring

Frightening

Arousal potential of situation ->
Most preferred arousal level

- **Sound preference**
  - Elliot
  - Hockey

- **Complexity preference**
  - Bartol

- **Extraversion and the “three F’s syndrome”**
  - Fags (cigarettes)
  - Fornication
  - Firewater
Logical problems with arousal preferences hypothesis

• What is arousing?
  – Mountain climbing? Chess playing? Small boat sailing?
• What has subject done before coming to laboratory
  – Extraverts being sociable
  – Introverts studying
Does Personality make a difference?

• Important Life Criteria
  – Longevity (Friedman et al.)
  – Job Performance (Hunter and Schmidt)
  – Psychological well being

• Laboratory tasks
  – Cognitive sensitivities and biases (eg., McCloud, Mathews, Matthews, etc.)
I-E and performance differences under stress and boredom

- Performance as a curvilinear function of arousal and task difficulty
  - Yerkes and Dodson, 1908
  - Hebb (1955)
  - Broadhurst (1958)
  - Broadbent (1971)
Yerkes and Dodson, 1908

Discrimination learning

**Fig. 1.** Discrimination box. W, electric box with white cardboards; B, electric box with black cardboards.

**Fig. 2.** Ground plan of discrimination box. A, nest-box; B, entrance chamber; W, W, electric boxes; L, doorway of left electric box; R, doorway of right electric box; E, exit from electric box to alley; O, swinging door between alley and A; I, induction apparatus; C, electric battery; K, key to circuit.
Yerkes and Dodson
Learning and shock level

Fig. 4. Curves of learning. Ordinates represent series of ten tests each, and abscissae represent the average number of errors for four mice in each series. W, designates the error curve for the individuals which were trained under the condition of weak electrical stimulation; M, designates the corresponding curve for the medium strength of stimulation; and S, that for the strong stimulus.
Fig. 5. A graphic representation of the relation of strength of electrical stimulus to condition of visual discrimination and rapidity of learning. Ordinates represent value of electric stimulus in units of stimulation; abscissae represent the number of tests given. Curve I represents the results of the experiments of Set I. Each dot indicates a value of stimulus which was used in the experiments. For example, the first dot to the left in curve I signifies that the stimulus whose value was 125 units gave a perfect habit, in the case of the four individuals trained, with 187 tests; the second dot, that for the stimulus value of 100 units 89 tests were necessary; and the third that for the stimulus value of 500, 155 tests. Curves II and III similarly represent the results of the experiments of sets II and III, respectively.
Fig. 5. A graphic representation of the relation of strength of electrical stimulus to condition of visual discrimination and rapidity of learning. Ordinates represent value of electric stimulus in units of stimulation; abscissae represent the number of tests given. Curve I represents the results of the experiments of Set I. Each dot indicates a value of stimulus which was used in the experiments. For example, the first dot to the left in curve I signifies that the stimulus whose value was 125 units gave a perfect habit, in the case of the four individuals trained, with 187 tests; the second dot, that for the stimulus value of 100 units 85 tests were necessary; and the third that for the stimulus value of 500, 155 tests. Curves II and III similarly represent the results of the experiments of sets II and III, respectively.
Yerkes and Dodson curve in terms of arousal and task difficulty

Performance

Arousal - >

Easy
Moderate
Hard
Yerkes and Dodson revisited

- Is it a lawful relationship?
- Does performance in fact vary as stress/arousal?
- Is there a relationship with task difficulty?
- Continues to be controversial interpretation
Hebb (1955) and arousal

- Level of “cue function as a function of arousal
- Arousal as pleasing up to a point
- Arousal as facilitating performance up to an optimal level
Hebb Curve (1955)

Level of Arousal function (non specific cortical bombardment)

Optimal Level of Response and Learning

Increasing Interest, Alertness, Positive Emotion

Deep Sleep

Point of awakening

Increasing Emotional Disturbance, anxiety

Level of “Cue Function” (or possibility thereof)
Eysenck and the Hebb Curve

- Performance as curvilinear function of arousal
- Introverts more aroused than extraverts
- Therefore, introverts should do well under low stress situations, extraverts in high stress situations
Eysenck + Hebb (1967)

Level of Arousal function (non specific cortical bombardment)

Level of “Cue Function” (or possibility thereof)

Optimal Level of Response and Learning

- Introvert
  - Deep Sleep
  - Point of awakening
  - Increasing Interest, Alertness, Positive Emotion

- Extravert
  - Increasing Emotional Disturbance, anxiety

- Point of awakening

Increasing Interest, Alertness, Positive Emotion

Increasing Emotional Disturbance, anxiety
Evidence in support of I-E performance hypothesis

• No curvilinearity, but consistent
  – Frith (1967) detection of flicker fusion
    • Quiet versus noise
    • Extraverts versus introverts
  – Corcoran (1972) tracking performance
    • Sleep deprivation (12, 36, 60 hours)
    • Extraversion-introversion
Supporting Evidence

- Curvilinear and consistent
  - Davies and Hockey (1966)
    - Detection task
    - Quiet versus noisy
    - Low versus high signal frequency
    - Extraverts versus introverts
    - (note that 2*2*2 design has many possible compatible results)
Supporting evidence

• Gupta 1977: IQ tests
  – 0, 5, 10, 15 mg of amphetamine
  – Extraverts versus introverts
  – But later work from their lab was plagiarized from Anderson leading one to question any findings from their lab
Feeble attempts at theory testing

• Revelle, 1973
  – Performance on digit symbol, maze tracking, and anagrams (3 levels of difficulty for each task)
  – 6 stress levels
    • 1 person, relaxed
    • 2 person, relaxed
    • 2 person, competing
    • 2 person, competing for money
    • 8 person, competing for money
    • 8 person, competing for money, noise
  – Mixed results
    • What is arousing?
Introversion, time pressure, and caffeine: effect on verbal performance

Verbal GRE Performance

Standardized for NU

Revelle, Amaral, & Turriff, 1976 Science

Stress-->
Multiple attempts at replication

• Multiple studies tried to replicate the original Revelle, Amaral and Turiff results
• Mixed results
  – Sometimes would see it
  – Sometimes would not
• Eventually discovered the problem
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

Revelle, Humphreys, Simon and Gilliland, JEP:G, 1980
Impulsivity, Caffeine, and Time of Day: the effect on complex cognitive performance

Revelle, Humphreys, Simon and Gilliland, JEP:G, 1980
Extraversion vs. Impulsivity

• Caffeine effects were systematic, but not for extraversion, but rather for impulsivity
• Systematic interaction with time of day
• Implications
  – Performance does vary as function of personality and arousal, but depends upon time of day
  – Personality dimension of relevance was impulsivity
General reanalysis of previous I-E effects -- were they impulsivity

- Relationship of impulsivity to extraversion
  - Old Eysenck scales were Impulsivity + Sociability
  - Newer scales (including Big 5 markers) are more sociability and ambition

- Theories of extraversion and arousal - were they theories of impulsivity?
Personality and Cognition: early attempts at a synthesis

• Humphreys and Revelle, 1984
  – Personality Traits x situational cues produce
  – Motivational States (arousal and on task effort)
  – Inverted U between arousal and performance is the result of two processes
    • Arousal facilitates Sustained Information Transfer (SIT) and inhibits Working Memory
    • On task effort facilitates SIT
Simple stage model of processing-
Personality effects at each stage

Conceptual Stages of Information Processing

Stimulus

Stimulus Detection and Selection

Stimulus Encoding

Information Integration

Response Selection and Execution

Feedback Loops

Memory of conditional probabilities of past events
Personality affects each stage of processing

- Introversion facilitates detection in vigilance tasks
- Anxiety facilitates detection of threat terms
- Depression facilitates memory for negative events
- Intelligence facilitates processing speed
Arousal and Performance
(Hypothetical description of Yerkes and Dodson Effect)
Arousal and Working Memory

The graph shows the relationship between arousal and working memory. The x-axis represents arousal levels, while the y-axis represents working memory levels. The curves indicate that as arousal increases, working memory decreases, with different curves possibly representing different conditions or groups.
Arousal and Information Transfer

Arousal

Sustained Information Transfer

Arousal
Arousal and Performance: Arousal, Working Memory and Information Transfer
Yet another “plumbing diagram” relating personality, affect, and cognition