Psychology 360: Personality Research
Introversion-Extraversion

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Outline

Descriptive vs. Causal models
  Descriptions of Introversion-Extraversion
  A personal digression

Eysenck’s influence on personality theory

Measurement

Eysenck, the development of theory
  Eysenck’s arousal theory as a theory of performance

Personality and Performance
  Personality and performance

Theory comparison and development
  Theory Testing

References
1. Simple descriptive basis
   - Self reports on SAPA correlated with other scales from the Big Few and the Little 27
   - Sociable
   - Active
   - Impulsive
   - Spontaneous

2. Peer ratings (As an example, Zola, Condon & Revelle (2021) asked for peer ratings of SAPA participants.)

3. People who describe themselves as outgoing are more known to others.
### Big Few and mighty many correlations with Extraversion

<table>
<thead>
<tr>
<th>Variable</th>
<th>Self Report</th>
<th>Peer ratings</th>
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<tbody>
<tr>
<td>Extraversion</td>
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<td>0.71</td>
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<tr>
<td>Sociability</td>
<td>0.78</td>
<td>0.67</td>
</tr>
<tr>
<td>Attention Seeking</td>
<td>0.70</td>
<td>0.42</td>
</tr>
<tr>
<td>Charisma</td>
<td>0.66</td>
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<tr>
<td>Humor</td>
<td>0.56</td>
<td>0.44</td>
</tr>
<tr>
<td>Emotional Expressiveness</td>
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<td>0.36</td>
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<td>Peer Ratings Extraversion</td>
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<td>Adaptability</td>
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<td>Sensation Seeking</td>
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<td>Anxiety</td>
<td>-0.29</td>
<td>-0.41</td>
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<td>Agreeableness</td>
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<td>Trust</td>
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<td>Neuroticism</td>
<td>-0.28</td>
<td>-0.40</td>
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<tr>
<td>Honesty Humility</td>
<td>-0.23</td>
<td>-0.06</td>
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<tr>
<td>Impulsivity</td>
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<td>-0.13</td>
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<td>Creativity</td>
<td>0.22</td>
<td>0.26</td>
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<tr>
<td>Easy Goingness</td>
<td>-0.22</td>
<td>-0.50</td>
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<td>Compassion</td>
<td>0.22</td>
<td>0.25</td>
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<td>Intellect</td>
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<td>0.31</td>
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<tr>
<td>Industry</td>
<td>0.20</td>
<td>0.51</td>
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<tr>
<td>Conservatism</td>
<td>0.16</td>
<td>0.29</td>
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<tr>
<td>Conscientiousness</td>
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<td>0.42</td>
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<tr>
<td>Openness</td>
<td>0.13</td>
<td>0.17</td>
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<td>Attractiveness</td>
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<td>Intellect Openness</td>
<td>0.09</td>
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<td>Self Control</td>
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<td>Irritability</td>
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<td>Introspection</td>
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<td>-0.05</td>
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<td>Stability</td>
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<tr>
<td>Conformity</td>
<td>-0.05</td>
<td>0.09</td>
</tr>
<tr>
<td>Emotional Stability</td>
<td>-0.04</td>
<td>-0.23</td>
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</table>

*Note: The table lists correlations with Extraversion, showing the relationships between Extraversion and various personality traits as measured by self-report and peer ratings.*
### Correlations of SAPA items with Extraversion score

<table>
<thead>
<tr>
<th>Variable</th>
<th>Extrv</th>
<th>item</th>
<th>B5</th>
<th>L27</th>
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</thead>
<tbody>
<tr>
<td>q_1027</td>
<td>-0.76</td>
<td>Hate being the center of attention.</td>
<td>Extra</td>
<td>AttentionSeeking</td>
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<tr>
<td>q_565</td>
<td>-0.75</td>
<td>Dislike being the center of attention.</td>
<td>Extra</td>
<td>AttentionSeeking</td>
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<tr>
<td>q_1904</td>
<td>0.74</td>
<td>Usually like to spend my free time with people.</td>
<td>Extra</td>
<td>Sociability</td>
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<tr>
<td>q_312</td>
<td>-0.73</td>
<td>Avoid company.</td>
<td>Extra</td>
<td>Sociability</td>
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<tr>
<td>q_1296</td>
<td>0.71</td>
<td>Like to attract attention.</td>
<td>Extra</td>
<td>AttentionSeeking</td>
</tr>
<tr>
<td>q_1416</td>
<td>0.70</td>
<td>Make myself the center of attention.</td>
<td>Extra</td>
<td>AttentionSeeking</td>
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<tr>
<td>q_254</td>
<td>0.70</td>
<td>Am skilled in handling social situations.</td>
<td>Extra</td>
<td>Charisma</td>
</tr>
<tr>
<td>q_901</td>
<td>-0.68</td>
<td>Find it difficult to approach others.</td>
<td>Extra</td>
<td>Charisma</td>
</tr>
<tr>
<td>q_1923</td>
<td>-0.68</td>
<td>Want to be left alone.</td>
<td>Extra</td>
<td>Sociability</td>
</tr>
<tr>
<td>q_4243</td>
<td>0.67</td>
<td>Like going out a lot.</td>
<td>Extra</td>
<td>Sociability</td>
</tr>
<tr>
<td>q_684</td>
<td>-0.66</td>
<td>Don’t like crowded events.</td>
<td>Extra</td>
<td>Sociability</td>
</tr>
<tr>
<td>q_803</td>
<td>0.63</td>
<td>Express myself easily.</td>
<td>Extra</td>
<td>EmotionalExpressiveness</td>
</tr>
<tr>
<td>q_1243</td>
<td>0.59</td>
<td>Laugh a lot.</td>
<td>Extra</td>
<td>Humor</td>
</tr>
<tr>
<td>q_1244</td>
<td>0.56</td>
<td>Laugh aloud.</td>
<td>Extra</td>
<td>Humor</td>
</tr>
<tr>
<td>q_1371</td>
<td>0.52</td>
<td>Love life.</td>
<td>Extra</td>
<td>WellBeing</td>
</tr>
<tr>
<td>q_219</td>
<td>0.49</td>
<td>Am open about my feelings.</td>
<td>EmotionalExpressiveness</td>
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<tr>
<td>q_1081</td>
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<td>Have difficulty expressing my feelings.</td>
<td>EmotionalExpressiveness</td>
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<tr>
<td>q_1045</td>
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<td>Have a natural talent for influencing people.</td>
<td>Charisma</td>
<td></td>
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<tr>
<td>q_3840</td>
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<tr>
<td>q_131</td>
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<td>Am good at making impromptu speeches.</td>
<td>Charisma</td>
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<tr>
<td>q_296</td>
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<td>Amuse my friends.</td>
<td>Humor</td>
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<tr>
<td>q_1635</td>
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<td>Reveal little about myself.</td>
<td>EmotionalExpressiveness</td>
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<tr>
<td>q_1242</td>
<td>-0.47</td>
<td>Lack the talent for influencing people.</td>
<td>Charisma</td>
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<tr>
<td>q_1248</td>
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<td>Laugh my way through life.</td>
<td>Humor</td>
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<tr>
<td>q_1052</td>
<td>-0.43</td>
<td>Have a slow pace to my life.</td>
<td>EasyGoingness</td>
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<tr>
<td>q_1781</td>
<td>0.41</td>
<td>Take risks.</td>
<td>SensationSeeking</td>
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<tr>
<td>q_1662</td>
<td>0.41</td>
<td>Seek adventure.</td>
<td>SensationSeeking</td>
<td></td>
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<tr>
<td>q_2765</td>
<td>0.41</td>
<td>Am happy with my life.</td>
<td>WellBeing</td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>Extrv</td>
<td>item</td>
<td>B5</td>
<td>L27</td>
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<td>q_312</td>
<td>-0.82</td>
<td>Avoid company.</td>
<td>Extra</td>
<td>Sociability</td>
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<tr>
<td>q_254</td>
<td>0.80</td>
<td>Am skilled in handling social situations.</td>
<td>Extra</td>
<td>Charisma</td>
</tr>
<tr>
<td>q_1371</td>
<td>0.73</td>
<td>Love life.</td>
<td>Extra</td>
<td>WellBeing</td>
</tr>
<tr>
<td>q_578</td>
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<td>Dislike myself.</td>
<td>Neuro</td>
<td>WellBeing</td>
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<tr>
<td>q_1052</td>
<td>-0.67</td>
<td>Have a slow pace to my life.</td>
<td>Extra</td>
<td>EasyGoingness</td>
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<tr>
<td>q_2765</td>
<td>0.67</td>
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<td>Extra</td>
<td>WellBeing</td>
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<td>Find it difficult to approach others.</td>
<td>Extra</td>
<td>Charisma</td>
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<tr>
<td>q_1904</td>
<td>0.62</td>
<td>Usually like to spend my free time with people.</td>
<td>Extra</td>
<td>Sociability</td>
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<tr>
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<td>-0.61</td>
<td>Want to be left alone.</td>
<td>Extra</td>
<td>Sociability</td>
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<tr>
<td>q_1744</td>
<td>0.61</td>
<td>Start tasks right away.</td>
<td>Consc</td>
<td>Industry</td>
</tr>
<tr>
<td>q_131</td>
<td>0.60</td>
<td>Am good at making impromptu speeches.</td>
<td>Consc</td>
<td>Charisma</td>
</tr>
<tr>
<td>q_1444</td>
<td>-0.59</td>
<td>Need a push to get started.</td>
<td>Consc</td>
<td>Conservatism</td>
</tr>
<tr>
<td>q_1328</td>
<td>0.58</td>
<td>Like to stand during the national anthem.</td>
<td>Consc</td>
<td>Conservatism</td>
</tr>
<tr>
<td>q_1027</td>
<td>-0.58</td>
<td>Hate being the center of attention.</td>
<td>Extra</td>
<td>AttentionSeeking</td>
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<tr>
<td>q_820</td>
<td>0.57</td>
<td>Feel comfortable with myself.</td>
<td>Extra</td>
<td>WellBeing</td>
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<tr>
<td>q_811</td>
<td>-0.55</td>
<td>Feel a sense of worthlessness or hopelessness.</td>
<td>Neuro</td>
<td>WellBeing</td>
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<td>q_1248</td>
<td>0.54</td>
<td>Laugh my way through life.</td>
<td>Extra</td>
<td>Humor</td>
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<td>q_4243</td>
<td>0.49</td>
<td>Like going out a lot.</td>
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<td>Sociability</td>
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<tr>
<td>q_1244</td>
<td>0.48</td>
<td>Laugh aloud.</td>
<td>Extra</td>
<td>Humor</td>
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<tr>
<td>q_90</td>
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<td>Am concerned about others.</td>
<td>Agree</td>
<td>Compassion</td>
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<td>q_1024</td>
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<td>Hang around doing nothing.</td>
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<td>EasyGoingness</td>
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<td>q_689</td>
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<td>Dont like the idea of change.</td>
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<td>Adaptability</td>
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<td>Fear for the worst.</td>
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<td>Anxiety</td>
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<td>Am a worrier.</td>
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<td>Anxiety</td>
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<tr>
<td>q_377</td>
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<td>Believe that others have good intentions.</td>
<td>Agree</td>
<td>Trust</td>
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<td>Feel that most people cant be trusted.</td>
<td>Agree</td>
<td>Trust</td>
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<tr>
<td>q_1662</td>
<td>0.46</td>
<td>Seek adventure.</td>
<td>Agree</td>
<td>SensationSeeking</td>
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<tr>
<td>q_565</td>
<td>-0.45</td>
<td>Dislike being the center of attention.</td>
<td>Extra</td>
<td>AttentionSeeking</td>
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<td>q_684</td>
<td>-0.44</td>
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<td>Extra</td>
<td>Charisma</td>
</tr>
</tbody>
</table>
Three reasons to study extraversion (Wilt & Revelle, 2009, 2016)

1. Extraversion as one of the broad “Big Few” (Möttus, Wood, Condon, Back, Baumert, Costani, Epskamp, Greiff, Johnson, Lukaszesksi, Murray, Revelle, Wright, Yarkoni, Ziegler & Zimmerman, 2020) and one of the “Giant 3” (Eysenck, 1994)

2. Extraversion predicts effective functioning and well-being across a wide variety of domains Ozer & Benet-Martinez (2006a)
   - from cognitive performance Matthews (1992)
   - social economic status Roberts, Kuncel, Shiner, Caspi & Goldberg (2007).

American Taxonomists – European Theorists

1. While most US researchers were studying the dimensionality of self reports, Europeans were developing casual models.

2. The most complete (and changing) causal model of extraversion was that of Hans Eysenck (Eysenck, 1967, 1990)

3. In the past 20 years the field has exploded in its interest in extraversion.
Where I first learned about personality theory (and Hans Eysenck)

Figure: Nanga Medamit, ulu Limbang, Sarawak, Malaysia, 1965-1967
My first exposure to Hans Eysenck
The only psychology books in the Brunei bookstore (100 Km or 10 hours by boat downriver) were by Hans Eysenck.
Who was this man?

Psychology occupies a somewhat ambiguous place in the world today. Its findings are being widely applied in clinics, in industry, in education, and in the armed forces. At the same time, many intelligent people are critical of the alleged laws of human behaviour discovered by psychologists, psychiatrists, and psychoanalysts, and doubtful about the applicability of scientific methods to the study of human beings. In this book, a well-known psychologist has tried to strike a balance, to indicate to what extent the claims made for his science are justified, and to what extent they fail to have any factual basis. The discussion is very fully documented by references to the most important and relevant research carried out in this country and abroad. Topics dealt with are the testing of intelligence, selection procedures in schools and universities, vocational guidance and occupational selection, psychotherapy and its effects, national differences, racial intolerance, Gallup surveys, industrial productivity, and many others. In each case, psychological findings are submitted to a searching criticism, and a clear distinction made between those uses of psychology where enough is known to support social action, and those abuses where personal opinions rather than experimentally demonstrated fact seem to be involved.

Cover design by Eric Kitson
The influence of Eysenck on personality and individual differences

1. Popular books
   - Uses and abuses of psychology (Eysenck, 1953)
   - Sense and nonsense in psychology (Eysenck, 1964)
   - Fact and fiction in psychology (Eysenck, 1965)

2. Scholarly books (a small selection)
   - Dimensions of personality (Eysenck & Himmelweit, 1947)
   - The scientific study of personality (1952)
   - The structure of human personality (1953)
   - The dynamics of anxiety and hysteria (1957)
   - The biological basis of personality (Eysenck, 1967)
   - Eysenck of extraversion (1973) (Edited reprints)
   - The measurement of personality (1976) (Ed.)
   - Personality and Individual differences (Eysenck & Eysenck, 1985)
   - A new look at intelligence (Eysenck, 1998)

See also (Revelle, 2016)
European personality research was a beacon of light in the “Dark Ages of personality”

• While personality was under attack in the US (Mischel, 1968; Endler & Magnusson, 1976) it was alive and well and living in Europe (Eysenck, 1967), Gray (1970, 1982, 1991), Strelau & Angleitner (1991)
  • It is hard to remember now in the third decade of the 21st century the attacks of the 60s-80s on the study of stable, biologically based, important personality traits.
  • These attacks had a perverse and long lasting influence on American personality research.
  • The scars of these debates persist in that a generation of American researchers avoided the field.
  • However, it is because of the contributions of (mainly) European personality researchers that we have such a vibrant field today.
• Whether we agree or disagree with Hans Eysenck’s theoretical program, we all owe a great debt to his contribution in advancing the field.
All American/European taxonomies of the 20th century include Extraversion

1. The Giant 3 of Eysenck (Eysenck, 1994)
   - Maudsley Personality Inventory (MPI) (Eysenck, 1959) (E and N)
   - Eysenck Personality Inventory (EPI) (Eysenck & Eysenck, 1967a) (E and N)
   - Eysenck Personality Inventory (EPQ) (Eysenck & Eysenck, 1975) (P, E, and N)

2. The NEO-PI-R (Costa & McCrae, 1985) (N, E, O, A, C)

3. IPIP (Goldberg, 1999) Open source personality items – IPIP-NEO - IPIP Big 5

4. (Tellegen, 1982) 7 dimensions

5. HEXACO (Lee & Ashton, 2004)

6. SPI (Condon, 2018) 135 item test including measures of E

7. BFAS (DeYoung, Quilty & Peterson, 2007) splits E into entusiasm and assertivenes
## Commonly used inventories measuring extraversion

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Abbreviation</th>
<th>Author</th>
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<tbody>
<tr>
<td>Abridged Big Five Circumplex</td>
<td>AB5C</td>
<td>Hofstee, de Raad, &amp; Goldberg</td>
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<tr>
<td>Big Five markers</td>
<td>BFM</td>
<td>Goldberg</td>
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<tr>
<td>Big Five Inventory</td>
<td>BFI</td>
<td>John, Donahue, &amp; Kentle</td>
</tr>
<tr>
<td>Big 5 Aspect Scales</td>
<td>BFAS</td>
<td>DeYoung, Quilty, &amp; Peterson</td>
</tr>
<tr>
<td>Eysenck Personality Inventory</td>
<td>EPI</td>
<td>H.J. &amp; S.B. Eysenck</td>
</tr>
<tr>
<td>Eysenck Personality Questionnaire</td>
<td>EPQ</td>
<td>S.B. &amp; H.J. Eysenck</td>
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<tr>
<td>Eysenck Personality Profiler</td>
<td>EPP</td>
<td>H.J. Eysenck &amp; G. D. Wilson</td>
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<tr>
<td>Five Factor Non Verbal</td>
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<td></td>
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<tr>
<td>Personality Questionnaire</td>
<td>FF-NPQ</td>
<td>Paunonen and Ashton</td>
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<tr>
<td>Guilford Zimmerman Personality Survey</td>
<td>GZTS</td>
<td>Guilford &amp; Zimmerman</td>
</tr>
<tr>
<td>HEXACO Personality Inventory</td>
<td>HEXACO-PI</td>
<td>Lee and Ashton</td>
</tr>
<tr>
<td>International Personality Item Pool</td>
<td>IPIP</td>
<td>Goldberg</td>
</tr>
<tr>
<td>Maudsley Personality Questionnaire</td>
<td>MPQ</td>
<td>H.J. Eysenck</td>
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<tr>
<td>Multidimensional Personality Questionnaire</td>
<td>MPQ</td>
<td>Tellegen</td>
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<tr>
<td>Neuroticism-extraversion-Openness</td>
<td></td>
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<tr>
<td>Personality Inventory Revised</td>
<td>NEO-PI-R</td>
<td>Costa &amp; McCrae</td>
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<tr>
<td>NEO Five Factor Inventory</td>
<td>NEO-FFI</td>
<td>Costa &amp; McCrae</td>
</tr>
<tr>
<td>Riverside Behavioral Q-Sort</td>
<td>RBQ</td>
<td>Funder, Furr, &amp; Colvin</td>
</tr>
</tbody>
</table>
Representative Items from extraversion scales emphasize Affective and Behavioral aspects

<table>
<thead>
<tr>
<th>Inventory</th>
<th>ABCD</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB5C</td>
<td>A</td>
<td>Radiate joy</td>
</tr>
<tr>
<td>BFI</td>
<td>A</td>
<td>I see myself as someone who is full of energy</td>
</tr>
<tr>
<td>GZTS</td>
<td>A</td>
<td>You are a happy-go-lucky individual</td>
</tr>
<tr>
<td>HEXACO</td>
<td>A</td>
<td>Am usually active and full of energy</td>
</tr>
<tr>
<td>MPQ</td>
<td>A</td>
<td>Have a lot of fun</td>
</tr>
<tr>
<td>NEO-FFI</td>
<td>A</td>
<td>I really enjoy talking to people</td>
</tr>
<tr>
<td>BFAS</td>
<td>B</td>
<td>Am the first to act</td>
</tr>
<tr>
<td>BFM</td>
<td>B</td>
<td>Talkative</td>
</tr>
<tr>
<td>EPI</td>
<td>B</td>
<td>Do you like going out a lot?</td>
</tr>
<tr>
<td>EPQ</td>
<td>B</td>
<td>Do you like telling jokes and funny stories to your friends?</td>
</tr>
<tr>
<td>EPP</td>
<td>B</td>
<td>Would you prefer to fight for your beliefs than let an important issue go unchallenged?</td>
</tr>
<tr>
<td>FF-NPQ</td>
<td>B</td>
<td>Picture of person riding a bucking horse</td>
</tr>
<tr>
<td>IPIP</td>
<td>B</td>
<td>Am the life of the party</td>
</tr>
<tr>
<td>MPQ</td>
<td>B</td>
<td>Do you like to mix socially with people?</td>
</tr>
<tr>
<td>NEO-PI-R</td>
<td>B</td>
<td>I am dominant, forceful, and assertive</td>
</tr>
<tr>
<td>RBQ</td>
<td>B</td>
<td>Exhibits social skills</td>
</tr>
</tbody>
</table>
### Top 20 Extraversion items from the Sapa Personality Inventory (SPI)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Item Description</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>q_1904</td>
<td>Usually like to spend my free time with people.</td>
<td>Sociability</td>
</tr>
<tr>
<td>q_565-</td>
<td>Dislike being the center of attention.</td>
<td>AttentionSeeking</td>
</tr>
<tr>
<td>q_1045</td>
<td>Have a natural talent for influencing people.</td>
<td>Charisma</td>
</tr>
<tr>
<td>q_1243</td>
<td>Laugh a lot.</td>
<td>Humor</td>
</tr>
<tr>
<td>q_219</td>
<td>Am open about my feelings.</td>
<td>EmotionalExpressiveness</td>
</tr>
<tr>
<td>q_312-</td>
<td>Avoid company.</td>
<td>Sociability</td>
</tr>
<tr>
<td>q_1027-</td>
<td>Hate being the center of attention.</td>
<td>AttentionSeeking</td>
</tr>
<tr>
<td>q_254</td>
<td>Am skilled in handling social situations.</td>
<td>Charisma</td>
</tr>
<tr>
<td>q_1244</td>
<td>Laugh aloud.</td>
<td>Humor</td>
</tr>
<tr>
<td>q_1081-</td>
<td>Have difficulty expressing my feelings.</td>
<td>EmotionalExpressiveness</td>
</tr>
<tr>
<td>q_1923-</td>
<td>Want to be left alone.</td>
<td>Sociability</td>
</tr>
<tr>
<td>q_1416</td>
<td>Make myself the center of attention.</td>
<td>AttentionSeeking</td>
</tr>
<tr>
<td>q_1248</td>
<td>Laugh my way through life.</td>
<td>Humor</td>
</tr>
<tr>
<td>q_803</td>
<td>Express myself easily.</td>
<td>EmotionalExpressiveness</td>
</tr>
<tr>
<td>q_4243</td>
<td>Like going out a lot.</td>
<td>Sociability</td>
</tr>
<tr>
<td>q_1296</td>
<td>Like to attract attention.</td>
<td>AttentionSeeking</td>
</tr>
<tr>
<td>q_901-</td>
<td>Find it difficult to approach others.</td>
<td>Charisma</td>
</tr>
<tr>
<td>q_296</td>
<td>Amuse my friends.</td>
<td>Humor</td>
</tr>
<tr>
<td>q_1635-</td>
<td>Reveal little about myself.</td>
<td>EmotionalExpressiveness</td>
</tr>
<tr>
<td>q_684-</td>
<td>Dont like crowded events.</td>
<td>Sociability</td>
</tr>
</tbody>
</table>
Obvious behavioral correlates

1. E’s talk more
   But this interacts with group size
2. More well known
3. Occupational differences
   Extraversion and success in sales
   (but is this ambition or sociability?)
4. Introversion and preference for isolation
5. Extraversion and stimulation seeking
   Higher risk of arrest (interacts with social class)
   Higher risk of auto accidents
6. Greater sexual activity
   E’s have
   More partners
   Earlier onset
   Prefer more positions
Eysenck’s theories as integration of individual differences with general laws

Eysenck always tried to integrate his taxometric study of individual differences with the best general psychological theories available at the time. That meant that the theory changed. (Although sometimes without comment.) Thus, to read Eysenck & Himmelweit (1947) or Eysenck (1952) is to read a completely different theoretical integration than proposed in Eysenck (1967) or Eysenck & Eysenck (1985) or finally, that of Eysenck (1997).

1. Personality and Learning Theory
   - Hull (1943, 1952)
   - Eysenck & Himmelweit (1947); Eysenck (1952)

2. Personality and Arousal Theory
   - Hebb (1955); Berlyne (1960); Berlyne & Madsen (1973); Broadbent (1971)
   - Eysenck (1967); Eysenck & Eysenck (1985)

3. Personality, genetics, structures, and neurotransmitters
### The original Eysenck factors (of behavior)

**Table:** The original Eysenck matrix

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age above 30</td>
<td>0.08</td>
<td>0.14</td>
<td>-0.27</td>
<td>-0.22</td>
</tr>
<tr>
<td>Unskilled</td>
<td>0.22</td>
<td>-0.45</td>
<td>0.12</td>
<td>-0.48</td>
</tr>
<tr>
<td>Unemployment</td>
<td>0.55</td>
<td>-0.23</td>
<td>-0.12</td>
<td>-0.36</td>
</tr>
<tr>
<td>Degraded work-history</td>
<td>0.16</td>
<td>-0.29</td>
<td>0.16</td>
<td>-0.29</td>
</tr>
<tr>
<td>Abnormality in parents</td>
<td>0.47</td>
<td>0.21</td>
<td>0.35</td>
<td>0.31</td>
</tr>
<tr>
<td>Unsatisfactory home</td>
<td>0.43</td>
<td>0.06</td>
<td>0.45</td>
<td>0.00</td>
</tr>
<tr>
<td>Married</td>
<td>0.21</td>
<td>0.39</td>
<td>-0.12</td>
<td>-0.19</td>
</tr>
<tr>
<td>No group membership</td>
<td>0.46</td>
<td>-0.40</td>
<td>-0.16</td>
<td>-0.32</td>
</tr>
<tr>
<td>Narrow interests</td>
<td>0.55</td>
<td>-0.57</td>
<td>0.04</td>
<td>-0.10</td>
</tr>
<tr>
<td>Alcohol</td>
<td>0.07</td>
<td>0.00</td>
<td>0.17</td>
<td>-0.36</td>
</tr>
<tr>
<td>Abnormal before illness</td>
<td>0.61</td>
<td>-0.09</td>
<td>0.24</td>
<td>0.33</td>
</tr>
<tr>
<td>Badly organized personality</td>
<td>0.92</td>
<td>-0.12</td>
<td>0.35</td>
<td>0.15</td>
</tr>
<tr>
<td>Dependent</td>
<td>0.65</td>
<td>-0.22</td>
<td>0.06</td>
<td>0.24</td>
</tr>
<tr>
<td>Little energy</td>
<td>0.53</td>
<td>-0.69</td>
<td>0.06</td>
<td>-0.24</td>
</tr>
<tr>
<td>Cyclothymic</td>
<td>0.46</td>
<td>0.31</td>
<td>0.00</td>
<td>0.37</td>
</tr>
<tr>
<td>Schizoid</td>
<td>0.52</td>
<td>-0.07</td>
<td>0.26</td>
<td>0.29</td>
</tr>
<tr>
<td>Hypochondriacal personality</td>
<td>0.31</td>
<td>-0.22</td>
<td>-0.41</td>
<td>0.07</td>
</tr>
<tr>
<td>Obsessional</td>
<td>0.00</td>
<td>0.51</td>
<td>0.07</td>
<td>0.25</td>
</tr>
<tr>
<td>Somatic anxiety</td>
<td>0.05</td>
<td>0.25</td>
<td>-0.37</td>
<td>0.12</td>
</tr>
<tr>
<td>Effort intolerance</td>
<td>0.23</td>
<td>0.13</td>
<td>-0.63</td>
<td>0.26</td>
</tr>
<tr>
<td>Dyspepsia</td>
<td>0.54</td>
<td>0.17</td>
<td>-0.36</td>
<td>-0.01</td>
</tr>
<tr>
<td>Fainting, fits</td>
<td>0.23</td>
<td>-0.23</td>
<td>-0.42</td>
<td>0.23</td>
</tr>
<tr>
<td>Pain</td>
<td>0.12</td>
<td>0.00</td>
<td>-0.39</td>
<td>0.03</td>
</tr>
<tr>
<td>Tremor</td>
<td>0.30</td>
<td>0.34</td>
<td>0.17</td>
<td>0.10</td>
</tr>
<tr>
<td>Sex anomalies</td>
<td>0.14</td>
<td>-0.50</td>
<td>0.54</td>
<td>-0.01</td>
</tr>
<tr>
<td>Irritability</td>
<td>0.18</td>
<td>0.41</td>
<td>0.13</td>
<td>-0.10</td>
</tr>
<tr>
<td>Apathy</td>
<td>0.18</td>
<td>0.48</td>
<td>-0.02</td>
<td>-0.46</td>
</tr>
</tbody>
</table>

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The first two unrotated factors from the Eysenck correlation matrix

First two unrotated dimensions of Eysenck refactored data
Learning theory

1. In the late 1940s to the late 1950’s, theories of learning were the major theoretical approach.

2. Eysenck’s first attempt to explain extraversion was based on the notions of excitation and inhibition Eysenck (1957), which were thought to influence the acquisition and extinction of behavior Pavlov (1927); Hull (1943). Specifically, Eysenck proposed that introverts had higher cortical excitability than extraverts, and thus would condition more efficiently.

3. Eysenck (and Spence) tried to integrate individual differences into these approaches by examining differential rates of learning

4. To Eysenck introverts condition more rapidly than extraverts (Eysenck & Himmelweit, 1947; Eysenck, 1952)

5. Thus, introverts learned to be rule followers, Extraverts not so much.
Differences in conditionability

1. Original hypothesis
   - Introverts are easily conditioned
   - Introverts become well socialized

2. Later findings
   - Conditioning differences depend upon situation
   - Low arousal situations lead to better conditioning for introverts
   - Impulsivity more important than extraversion (Eysenck & Levey, 1972; Levey & Martin, 1981)

   - Does pooling good studies with bad really provide the best estimate of an overall effect?
   - But how to choose good studies?
   - Inconsistency between Spence lab and Eysenck lab in terms of conditioning results.
   - Greg Kimble compared the two labs, differed in the subtle ways that the experimenters treated subjects.
   - Does pooling across different studies really work?
I-E and conditioning

A good theory should be lead to programmatic research with modifications reflecting new data.

1. (Newman, Widom & Nathan, 1985; Patterson, Kosson & Newman, 1987) work on psychopaths and conditioning
   • inability to stop


   • Sensitivity to cues of reward and action (impulsivity)
   • Sensitivity to cues of punishment and inaction (anxiety)

4. Gray’s revised model of Reinforcement Sensitivity Theory (Gray & McNaughton, 2000; Corr, 2002)
The Gray model

Gray’s hypothesis

- Anxious
- Neurotic
- Impulsive

- Introverts
- Non-impulsive
- Sensitivity for Cues for Reward

- Extraverts
- Non-anxious
- Sensitivity for Cues for Punishment
In 1960’s experimental research by Broadbent (1971) and others highlighted arousal


2. Concerned with effective performance and the effect of
   - Sleep deprivation
   - Noise
   - Stress

3. Introducing the arousal construct as the common theme to these manipulations was a change from the simple behaviorist approach.

4. Others noticed that Eysenck was studying similar manipulations and phenomena.
Hypothesis of arousal differences

1. What is arousal?
   - Arousal of the hand, the heart, and the head
   - Skin conductance
   - Heart rate
   - EEG desynchronization

   - Energetic arousal
   - Tense arousal

3. The Motivational State Questionnaire (MSQ) had 75 items selected from (Thayer, 1970; Watson, Clark & Tellegen, 1988; Larsen & Diener, 1992)
   MSQ data were collected over 10 years for 3800 participants.
   Data are available as the msq data set in the psychTools package
Measuring Tense and Energetic Arousal

2 dimensions of the Motivational State Questionnaire
Representative MSQ items arranged by angular location

<table>
<thead>
<tr>
<th>Variable</th>
<th>PA</th>
<th>NA</th>
<th>θ</th>
<th>Vector length</th>
</tr>
</thead>
<tbody>
<tr>
<td>wide.awake</td>
<td>0.74</td>
<td>0.00</td>
<td>0.21</td>
<td>0.74</td>
</tr>
<tr>
<td>alert</td>
<td>0.76</td>
<td>0.01</td>
<td>1.01</td>
<td>0.76</td>
</tr>
<tr>
<td>full.of.pep</td>
<td>0.84</td>
<td>0.03</td>
<td>1.77</td>
<td>0.84</td>
</tr>
<tr>
<td>lively</td>
<td>0.86</td>
<td>0.03</td>
<td>2.14</td>
<td>0.86</td>
</tr>
<tr>
<td>energetic</td>
<td>0.86</td>
<td>0.04</td>
<td>2.89</td>
<td>0.86</td>
</tr>
<tr>
<td>elated</td>
<td>0.73</td>
<td>0.04</td>
<td>3.03</td>
<td>0.73</td>
</tr>
<tr>
<td>active</td>
<td>0.82</td>
<td>0.06</td>
<td>3.96</td>
<td>0.82</td>
</tr>
<tr>
<td>anxious</td>
<td>0.28</td>
<td>0.56</td>
<td>63.02</td>
<td>0.63</td>
</tr>
<tr>
<td>nervous</td>
<td>0.21</td>
<td>0.62</td>
<td>71.01</td>
<td>0.66</td>
</tr>
<tr>
<td>afraid</td>
<td>0.12</td>
<td>0.62</td>
<td>78.90</td>
<td>0.63</td>
</tr>
<tr>
<td>fearful</td>
<td>0.11</td>
<td>0.61</td>
<td>79.79</td>
<td>0.62</td>
</tr>
<tr>
<td>sad</td>
<td>-0.08</td>
<td>0.66</td>
<td>97.15</td>
<td>0.67</td>
</tr>
<tr>
<td>lonely</td>
<td>-0.09</td>
<td>0.52</td>
<td>99.93</td>
<td>0.53</td>
</tr>
<tr>
<td>blue</td>
<td>-0.14</td>
<td>0.63</td>
<td>102.66</td>
<td>0.65</td>
</tr>
<tr>
<td>unhappy</td>
<td>-0.17</td>
<td>0.68</td>
<td>103.78</td>
<td>0.70</td>
</tr>
<tr>
<td>depressed</td>
<td>-0.18</td>
<td>0.66</td>
<td>105.31</td>
<td>0.68</td>
</tr>
<tr>
<td>tired</td>
<td>-0.53</td>
<td>0.14</td>
<td>165.32</td>
<td>0.54</td>
</tr>
<tr>
<td>sleepy</td>
<td>-0.50</td>
<td>0.13</td>
<td>165.78</td>
<td>0.52</td>
</tr>
<tr>
<td>drowsy</td>
<td>-0.50</td>
<td>0.12</td>
<td>166.68</td>
<td>0.51</td>
</tr>
<tr>
<td>calm</td>
<td>0.08</td>
<td>-0.40</td>
<td>281.25</td>
<td>0.41</td>
</tr>
<tr>
<td>serene</td>
<td>0.10</td>
<td>-0.33</td>
<td>287.11</td>
<td>0.34</td>
</tr>
<tr>
<td>relaxed</td>
<td>0.21</td>
<td>-0.44</td>
<td>295.22</td>
<td>0.49</td>
</tr>
<tr>
<td>at.ease</td>
<td>0.29</td>
<td>-0.45</td>
<td>302.64</td>
<td>0.54</td>
</tr>
<tr>
<td>at.rest</td>
<td>0.20</td>
<td>-0.31</td>
<td>302.84</td>
<td>0.37</td>
</tr>
<tr>
<td>content</td>
<td>0.54</td>
<td>-0.36</td>
<td>326.45</td>
<td>0.64</td>
</tr>
<tr>
<td>satisfied</td>
<td>0.58</td>
<td>-0.27</td>
<td>335.30</td>
<td>0.64</td>
</tr>
<tr>
<td>warmhearted</td>
<td>0.57</td>
<td>-0.18</td>
<td>342.37</td>
<td>0.60</td>
</tr>
<tr>
<td>happy</td>
<td>0.71</td>
<td>-0.23</td>
<td>342.42</td>
<td>0.75</td>
</tr>
<tr>
<td>attentive</td>
<td>0.72</td>
<td>-0.02</td>
<td>358.53</td>
<td>0.72</td>
</tr>
<tr>
<td>enthusiastic</td>
<td>0.80</td>
<td>-0.01</td>
<td>359.12</td>
<td>0.80</td>
</tr>
</tbody>
</table>
Sedation threshold (Shagass, 1958)

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

1. Light Sensitivity (threshold)  
   (Siddle, Morrish, White & Mangan, 1969) staircase method

2. Sound sensitivity  
   (Smith, 1968) forced choice

3. Electrocutaneous threshold  
   (Edman, Schalling & Rissler, 1979)

4. Pain sensitivity  
   Barnes (1975) integrated several studies

5. Bi-modal sensitivity  
   (Shigehisa & Symons, 1973)

6. Reaction to lemon juice  
   (Eysenck & Eysenck, 1967b; Corcoran & Houston, 1977; Corcoran & Hajduk, 1980; Deary, Ramsay,  
   Wilson & Riad, 1988)

Many of these were small sample studies – problem of replication and over interpretation, We would now worry about experimenter degrees of freedom, p hacking, selective reporting.
Basal arousal differences

1. Detected in psychophysiological experiments (Stelmack, 1990)
2. Electrophysiology (EEG) Now you see it, now you don’t Gale (1981)
   - In very boring, or very exciting situations, Es > I
   - But in relatively average situations, I > E.
3. Gale, Coles & Blaydon (1969) suggestion conditions need to be just right
4. Was this a problem of non-replicability of low powered experiments?
5. Or over reliance on theory driven but inadequate research methods?
6. Confirmatory studies, selective publishing of supporting studies?
Basal arousal differences (continued)

3. Spontaneous GSR (Crider & Lunn, 1971; Crider, 2008)
5. All of these studies show predicted differences between high and low introversion-extraversion. But are the results real?
Sedation threshold (Shagass, 1958)

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.
Body temperature and time of day

1. Blake (1967) was cited as showing biological differences related to arousal but how relevant is this to basic theory?

2. Folkard (1976)


Blake and time of day

Fig. 1. Mean circadian rhythm of body temperature in introvert and extravert groups.
The Wundt curve of hedonic tone

Wundt’s hedonic curve
(adapted from Berlyne)

Hedonic tone ->

Pleasant

Boring

Frightening

Arousal potential ->
Extraversion, arousal, and hedonic tone

1. If introverts are more aroused than extraverts (or more accurately, if introversion-extraversion is negatively correlated with arousal)

2. If there is an optimal level of arousal ((Wundt, 1904)

3. Then, those more introverted should prefer less external stimulation than those more extraverted.
Eysenckian prediction of optimal hedonic arousal

Wundt’s hedonic curve + Individual Differences

(adapted from Eysenck)
Berlyne hypothesis

Berlyne’s hedonic curve
(adapted from Berlyne)

Hedonic tone ->

Arousal potential ->

Calming

Exciting

Boring

Adaptation to Current State

Frightening
Behavioral Consequences of arousal differences

1. Differences in Arousal preference

2. Wundt’s curvilinear hypotheses
   • Moderate levels of arousal are more pleasing than extreme levels
   • ("the Goldilocks hypothesis")

3. (Berlyne, 1960)
   • Changes in arousal are more pleasing than a steady state
   • Increases or decreases are pleasant
Most preferred arousal level

1. Sound preference  
   (Elliott, 1971)  
   (Davies, G.R.G.Hockey & Taylor, 1969)

2. Complexity preference – (Bartol, 1975)

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

1. What is arousing?
   Mountain climbing?
   Chess playing?
   Small boat sailing?

2. What has subject done before coming to laboratory
   Extraverts being sociable
   Introverts studying
Does Personality make a difference?

1. Important Life Criteria
   - Longevity (Friedman, Tucker, Schwartz, Tomlinson-Keasey, Martin, Wingard & Criqui, 1995)
   - Job Performance (Schmidt & Hunter, 2004)
   - Psychological well being (Ozer & Benet-Martinez, 2006b)

2. Laboratory tasks
   - Cognitive sensitivities and biases e.g., (Williams, Mathews & MacLeod, 1996)
Performance as a curvilinear function of arousal and task difficulty

1. Yerkes & Dodson (1908)
2. (Hebb, 1955)
3. (Broadhurst, 1957, 1959)
4. (Broadbent, 1971)
Discrimination Learning in the mouse

**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*; *IC*, induction apparatus; *C*, electric battery; *K*, key in circuit.
Discrimination Learning in the mouse: interacts with task difficulty
Yerkes and Dodson revisited

1. Is it a lawful relationship?
2. Does performance in fact vary as stress/arousal?
3. Is there a relationship with task difficulty?
(Hebb, 1955) and arousal

1. Level of “cue function” as a function of arousal
2. Arousal as pleasing up to a point
3. Arousal as facilitating performance up to an optimal level
State of the art theory in 1955—Hebb’s Conceptual Nervous System

Hebb Curve (1955)

Optimal Level of Response and Learning

Level of “Cue Function” (or possibility thereof)

Increasing Interest, Alertness, Positive Emotion

Point of awakening

Deep Sleep

Increasing Emotional Disturbance, anxiety

Level of Arousal function (non specific cortical bombardment)
Eysenck and the Hebb Curve

1. Performance as curvilinear function of arousal
2. Introverts more aroused than extraverts
3. Therefore, introverts should do well under low stress situations, extraverts in high stress situations
Predicting individual differences in performance under stress

Eysenck (1967) + Hebb (1955)

Optimal Level of Response and Learning

Level of Arousal function (non specific cortical bombardment)

Level of “Cue Function” (or possibility thereof)

Deep Sleep

Point of awakening

Increasing Interest, Alertness, Positive Emotion

Introvert

Increasing Emotional Disturbance, anxiety

Extravert
Evidence in support of I-E performance hypothesis

1. No curvilinearity, but consistent (Frith, 1967) detection of flicker fusion
   Quiet versus noise
   Extraverts versus introverts

2. (Corcoran, 1965, 1972) tracking performance
   Sleep deprivation (12, 36, 60 hours)
   Extraversion-introversion
Supporting evidence

Curvilinear and consistent

1. (Davies & Hockey, 1966; Davies et al., 1969)
   Detection task
   Quiet versus noisy
   Low versus high signal frequency
   Extraverts versus introverts

2. (note that 2*2*2 design has many possible compatible results)
Feeble attempts at theory testing (Revelle, 1973)

1. Performance on digit symbol, maze tracking, and anagrams (3 levels of difficulty for each task)

2. 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

3. Mixed results

4. What is arousing?
Confirmation experiment ≠ theory testing: The example of caffeine by extraversion

1. Basic hypothesis
   - Introverts are more aroused than extraverts Eysenck (1967)
   - Caffeine or time stress will increase arousal
   - Performance is a curvilinear function of arousal (Yerkes & Dodson, 1908; Hebb, 1955; Easterbrook, 1959; Broadbent, 1971)

2. Revelle et al. (1976)
   - I-E measured with Eysenck Personality Inventory
   - caffeine given as placebo or 200 mg in capsule
   - Performance on practice Graduate Record Exams (GRE), reported in standardized scores

3. Predictions
   - Introverts > extraverts in relaxed condition
   - Introverts < extraverts with time pressure and caffeine
Caffeine and time stress on complex performance

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

Verbal GRE Performance

Standardized for NU

- Introverts
- Ambiverts
- Extraverts

Revelle, Amaral, & Turriff, 1976 Science
Failures to replicate can lead to better science for they show the limits of an effect.

1. Kirby Gilliland (1976) failed to replicate the Revelle et al. (1976) effect
   - A better study, caffeine was dosed by body weight and had 3 levels of caffeine
   - Used the Eysenck Personality Questionnaire (EPQ) instead of Eysenck Personality Inventory (EPI)
   - Failed to find the same results

2. Did replicate the results when using the EPI (Gilliland, 1980)

3. What was the difference?
Gilliland’s dissertation results did not replicate Revelle et al. (1976)

Figure: From Gilliland (1976)
Gilliland (1980) replicated (Revelle et al., 1976) when using EPI.

Extraversion, Caffeine, and Cognitive Performance

Using psychometrics to explain experimental results: Rocklin & Revelle (1981)

1. Eysenck Personality Inventory
   - Extraversion
   - Neuroticism

2. The new and improved Eysenck Personality Questionnaire
   - Extraversion
   - Neuroticism
   - Psychoticism

3. Cross form correlations were high for E (.74) and N (.83)

4. Structure was completely different for the two Extraversion scales
   - Number of factors determined by the Very Simple Structure criterion (Revelle & Rocklin, 1979)
   - 2 primary factors of EPI E (sociability and impulsivity)
   - one factor for EPQ E

5. This led to a small cottage industry of replications using EPI instead of EPQ (e.g., Campbell, 1983; Campbell & Heller, 1987).
Theory testing and rejecting by finding limiting cases

1. Over three years, we could replicate the Revelle et al. (1976) study about half the time.
   - We tested many different explanations, none worked.
   - Had varied time of day because we thought everyone would be more aroused later in the day. That is we hypothesized
     - $E < I$
     - $am < pm$
     - $placebo < caffeine$

2. Eventually we found a consistent interaction of Imp x drug x Time if we assumed an inverted U relationship of arousal and performance and
   - $E_{am} < I_{am}$
   - $I_{pm} < E_{pm}$
   - $placebo < caffeine$

Theory testing by rejection: The example of time of day x caffeine

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

[Graph showing AM Performance with Placebo and Caffeine conditions, high and low impulsives]

Cognitive Performance (median standard scores)
-0.4
0.0
0.2
0.4

AM Performance

High Impulsives
Low Impulsives

Placebo Caffeine
Theory testing by rejection: The example of time of day x caffeine

Impulsivity, Caffeine, and Time of Day: the effect on complex cognitive performance
Using experimental data for correlational analysis: body temperature and personality

1. Charmane Eastman had examined core body temperature over two weeks to study the effects of shift work.
   - Multiple, small experimental studies
   - Each study had included measures (MMPI-2) that could be interpreted as impulsivity.
   - Each study included measures of morningness-eveningness.

2. Erin Baehr synthesized these studies to examine individual differences in body temperature.
   - We also measured average bed time and average rise time for all subjects.
   - Acrophase of Body Temperature differed more than differences in behavior (biology meets society)

3. Although we plot the data in terms of Morningness/Eveningness, somewhat weaker results were true for impulsivity (Baehr, Revelle & Eastman, 2000).

Biology meets society – time of day and morningness/eveningness

Figure: Core body temperature from 171 volunteers averaged over a week. (Baehr et al., 2000)
Theory development by integrating multiple alternative theories

Multiple theories about personality and efficient performance

1. H.J. Eysenck (1967) and arousal theory
   - Introverts more aroused than Extraverts
   - Arousal has an inverted U relationship to performance

2. J.W. Atkinson (1957, 1974) and achievement motivation theory
   - High need achievement and low test anxiety lead to high motivation (Atkinson, 1957)
   - Motivation has inverted U relationship to performance (Atkinson, 1974)
   - Motivation has inertial properties (Atkinson & Birch, 1970; Revelle & Michaels, 1976; Revelle, 1986)

3. Theories of anxiety and cognitive performance
   - Anxiety and task difficulty (Spence, Farber & McFann, 1956)
   - Anxiety and working memory (Eysenck & Mathews, 1987; Eysenck, Derakshan, Santos & Calvo, 2007; Eysenck, 2000)
   - Anxiety and resource allocation (Wine, 1971)

4. Easterbrook (1959) and the Yerkes & Dodson (1908) “law”

1. Multiple dimensions of personality relating to efficient cognitive performance
   - Introversion/Extraversion – Impulsivity
   - Anxiety (not just neuroticism)
   - Achievement motivation

2. Decomposing motivation
   - Arousal
   - Effort

3. Decomposing Performance
   - Attention tasks
   - Short term (working) memory tasks
   - Complex tasks that reflect some mixture of attention and memory
The Yerkes Dodson effect varies by task difficulty
Coombs’ dictum

1. Any function where the first or second derivative changes sign may be decomposed into two processes (Coombs & Avrunin, 1977)
2. Performance as a singled peaked function of arousal.
3. Decompose that function into two monotonic functions: (Humphreys & Revelle, 1984)
4. Working memory decreases as arousal increases.
5. Sustained Information Transfer increases with arousal.
Arousal effects on working memory
Arousal effects on Sustained Information Transfer (attention)
Performance = SIT + STM
But performance varies not just by arousal

1. Arousal affects resource availability
2. Effort affects resource allocation
3. Can integrate several personality dimensions in terms of effort and arousal.
3 levels of processing (after Broadbent)

Upper Mechanism
where increasing demands leads to arousal inducing activities

Middle Mechanism
whose increasing activity reduces effects of sub or super optimal lower level monitors and alters parameters of lower level to maintain constant performance

Lower Mechanism
for whose activity there is an optimum decision criterion executes well established decision processes

- Incentives
- Task importance
- Extraversion
- Time of Day
- Time on task
- Alcohol
- Sleep deprivation
- Noise shifts

(Revelle, 1993; Ortony, Norman & Revelle, 2005)
A "simple" model of personality and performance

Adapted from Humphreys & Revelle, 1984; Revelle, 1989
Personality, Motivation, and Cognitive Performance

Adapted from Humphreys & Revelle, 1984; Revelle, 1989
Theory testing by critical comparisons

1. Theories differ in breadth and depth
   • Many theories are silent for some phenomenon
   • Some sets of theories are mutually compatible, but with different range

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2. We test alternative theories by looking for where they make different predictions.

3. It is not enough to disconfirm a theory, we must show better alternatives.
Testing four models of conditioning: Zinbarg & Revelle (1989b)

1. Drive Theory (Hull, 1943; Spence, 1964)
   - Anxiety and performance (Spence et al., 1956) but see Weiner & Schneider (1971)

2. Eysenck (1967); Eysenck & Eysenck (1985) specify the variables that affect conditioning:
   - Partial reinforcement
   - weak conditioned stimuli
   - discrimination learning


4. Extravert’s focus on reward blinds them to punishment Newman et al. (1985); Patterson et al. (1987)
Zinbarg & Revelle (1989b) used a go-nogo discrimination task

Tests of competing theories of anxiety and information processing
Leon & Revelle (1985)

How does anxiety affect performance?

1. Anxiety interacts with task difficulty Spence et al. (1956)
   • But see Weiner & Schneider (1971)

2. Anxiety limits working memory capacity Eysenck & Mathews (1987); Eysenck et al. (2007); Eysenck (2000)

3. Anxiety narrows the breadth of attention Easterbrook (1959)

4. Anxiety leads to off task thoughts Wine (1971)

Geometric analogies differing in memory load (transformations) and complexity (number of elements)

Figure 1. Sample 3-element two-transformation analogy problem.
Memory load, stress and anxiety Leon & Revelle (1985)

Figure 3. Error rates and response times for true analogies. (Error rates are calculated for all true analogies.)
Integrating cognitive theory with personality theory: Impulsivity, arousal and breadth of processing

1. Strong theories make testable predictions and theory develops by testing these predictions. Who is better able to test one’s theories than oneself?
Integrating cognitive theory with personality theory: Impulsivity, arousal and breadth of processing

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3. We examined this effect at two times of day and unexpectedly found a time of day by impulsivity interaction.
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4. But science advances by disconfirmation as well:
   - “Two particular models deserve attention here. First, these data obviously contradict our own previous arguments (e.g., Revelle et al., 1987; Revelle & Anderson, 1992) that impulsivity is linked to stable differences in rate of change in arousal states.” (Anderson & Revelle, 1994)
Integrating experimental and correlational data: Aggregating data across experimental studies for psychometric analysis

1. For about 10 years, we collected mood and arousal data as part of every experimental study we did.
   - Typical design was a mood pretest
   - Some arousal or motivation manipulation (e.g., caffeine, time stress, movies)
   - Then some post test

2. Motivational State Questionnaire (MSQ) was formed from items taken from Thayer’s AD-ACL Thayer (1978), the PANAS (Watson et al., 1988) and various circumplex measures of emotion (Larsen & Diener, 1992)

3. Factor structure of the 72 items for 3896 subjects and their correlations with basic personality scales from the EPI is reported by Rafaeli & Revelle (2006)

4. The actual data are available as the `msq` data set in the `psych` package (Revelle, 2022) in R.
Dimensions of the Motivational State Questionnaire

Dimensions of affect

- Energetic Arousal
- Tense Arousal


Eaton, L. G. & Funder, D. C. (2003). The creation and


Personality Questionnaire (Junior and Adult). Kent, UK: Hodder & Stoughton.


Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G.


Goldberg, L. R. (1999). A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. Deary, F. De Fruyt, &
F. Ostendorf (Eds.), *Personality psychology in Europe*, volume 7 (pp. 7–28). Tilburg, The Netherlands: Tilburg University Press.


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Thayer, R. E. (1978). Toward a psychological theory of


