Extraversion and Impulsivity: The lost dimension?

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> " ... quick intelligence, memory, sagacity, cleverness, and similar qualities, do not often grow together, and ... persons who possess them and are at the same time high-spirited and magnanimous are not so constituted by nature as to live in an orderly and peaceful and settled manner; they are driven any way by their impulses, and all solid principle goes out of them.
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> ... On the other hand, those stable and steadfast and, it seems, more trustworthy natures, which in a battle are impregnable to fear and immovable, are equally immovable when there is anything to be learned; they are always in a torpid state, and are apt to yawn and go to sleep over any intellectual toil."
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> (Plato, *The Republic, Book 6* 503c from Benjamin Jowett Fourth Edition).

2350 years after Plato described a dimension of impulsivity, psychologists are still concerned with those who are unable to live in an orderly and peaceful manner. Impulsive children and adults are carefree, long for excitement, act rapidly and without thinking, and respond to dares and challenges. Compared to the less impulsive, they are more likely to be found sky diving or hang gliding, to have automobile accidents and traffic violations, to be arrested, to commit violent suicide, and to perform better under high time stress conditions. In childhood, impulsivity is linked to difficulties in sustained attention and is a core feature of the diagnostic category of Attention Deficit Disorder. In adulthood, impulsivity is linked to behavior difficulties and to psychopathy.

Impulsivity has had a varied role in the study of personality and temperament and an even more varied role in the work of Hans Eysenck. While impulsivity was at one point a core feature of extraversion (Eysenck, 1967; H.J. Eysenck and S.B.G. Eysenck, 1967; S.B.G. Eysenck and H.J. Eysenck, 1963, 1979) that was said to be married in a shotgun wedding with Sociability (Guilford, 1975), it is now seen by some as a component of Psychoticism (Eysenck, 1990, 1991a, 1992; H.J. Eysenck and M.W. Eysenck, 1985) and by others as a central component of uncontrolled stimulation seeking and psychopathic behavior (P-Imp-USS, Zuckerman, 1994). Considered a facet of emotionality (Costa and McCrae, 1992) or non-conscientiousness (Digman, 1994) impulsivity has had a varied life in its identification in three, four, or five dimensional personality space. At the same time as it has suffered from an identity crisis in terms of measurement (Rocklin and Revelle, 1981) impulsivity has been identified as a central feature in arousal based theories of cognitive performance (Anderson & Revelle, 1994; Humphreys and Revelle, 1984; Revelle, 1989; Revelle, Humphreys, Simon and Gilliland, 1980) that has a strong biological basis (Schalling and Åsberg; 1985; Zuckerman, 1991). This chapter reviews a small part of the extensive literature on impulsivity and extraversion and discuss the vital research contribution that Hans Eysenck and his colleagues have made to understanding this important personality trait.

Impulsivity and the structure of personality

In the first three-dimensional model of temperament Heymans related impulsivity to a bias towards the primary effects of stimulation versus a bias towards secondary or reflective processing (Heymans, 1929 as cited by Van der Werff and Verster, 1987; Van der Werff, 1985). Considering secondary functioning, in combination with two other dimensions, emotionality and activity, allowed Heymans to go beyond the personality types of Galen and to introduce dimensional thinking into personality research. In later reanalyses of Heymans' data, ratings of impulsivity had high loadings on the "secondary function" factor and were associated with being lively and busy, demonstrative, violent, but not calm, quiet, or thoughtful (Van der Werff and Verster, 1987).

In his *Explorations of Personality*, Murray considered "Impulsion" as "the tendency to respond ... quickly and with out reflection" and as characterizing someone who "is usually restless, quick to move, quick to make up his mind, quick to voice his opinion. He often says the first thing that comes into his head; and does not always consider the future consequences of his conduct." (Murray, 1938, p 205).

Impulsivity and Extraversion--the early years

Although impulsivity does not appear in the index of *The Dimensions of Personality* (Eysenck, 1947), within nine years the basic self report measure of extraversion was a mixture of sociability and impulsivity (Eysenck, 1956). Two years later, impulsivity represented three of the six items in a short measure of extraversion (Eysenck, 1958; See Table 1). It is interesting to note that sociability, which would come to play such a dominant part of the Extraversion construct, was not considered an important component of extraversion in 1947 and was at most half of Extraversion in 1958.

Insert Table 1 about here

By 1960, the *Maudsley Personality Inventory* (Eysenck, 1959) extraversion scale was criticized as being factorially complex and as representing a mixture of sociability and impulsivity (Carrigan, 1960). To the Eysencks this mixture of impulsivity and sociability represented the dual nature (S.B.G. Eysenck and H.J. Eysenck, 1963, 1969) of a unitary dimension (H.J. Eysenck & S.B.G. Eysenck, 1967, 1969). The Eysencks as well as Sparrow and Ross (1964) showed that Extraversion items form two correlated factors as would be predicted from the hierarchical formulation of Extraversion (Eysenck, 1967). (It is interesting to compare the hierarchical model from 1947 with that of 1967 and 1969. In 1947 Introversion at the "Type" level was made up of the "Traits" of Persistence, Rigidity, Autonomic Imbalance, Accuracy, and Irritability. In 1967 and 1969 a similar appearing figure showed Extraversion at the Type level to be composed of Sociability, Impulsiveness, Activity, Liveliness, and Excitability. The 1967 figure is said to be "reprinted with slight changes" from the 1947 text. In fact, except for the structural characteristics of a hierarchy ranging from specific responses to habitual responses to traits to types, there seems to be no overlap between the two conceptions of Extraversion. This subtly changing nature of extraversion and the place of impulsivity within Eysenck's theory would continue to be a question for the next 30 years.)

In the following years the *Maudsley Personality Inventory* was modified to improve the factor structure of the Extraversion scale and to increase the independence of E and N. An early revision, the *Eysenck Personality Inventory* (EPI; Eysenck and Eysenck, 1964) had a 24 item Extraversion scale made up predominantly of Sociability and Impulsivity items (Table 1). With this combination of the sub domains, E was almost orthogonal to N. Over the next ten years the EPI was the operational definition of Extraversion and was the basis for a great deal of genetic, physiological, and cognitive research.

Some of this work was reviewed in *The Biological Basis of Personality* (Eysenck, 1967), an impressive summary of the behavioral and biological correlates of Extraversion and Neuroticism that provided a road map for the next three decades of research on Extraversion. In addition to reviewing the many physiological correlates of Extraversion and Neuroticism, Eysenck laid out the fundamental hypotheses about the relationship between Extraversion and arousal that would be the core of experimental and physiological research on extraversion. What is interesting in retrospect is that the book did not, however, make any distinction between impulsivity and sociability, and in fact rejected as implausible any consideration of a rotation from the basic N and E dimensions.

Impulsivity and the dual nature of extraversion

As experimental research focused on the behavioral, cognitive, and physiological correlates of Extraversion, psychometric research focused on difficulties in its measurement.

The EPI-E scale was criticized by Guilford (1975) as representing a "shotgun marriage" of sociability and impulsivity; a position that Eysenck (1977) strongly rejected. Although the centroid of impulsivity items was about 60 degrees away from that of a set of sociability items Guilford (1977) argued that it was possible to recover pure and orthogonal measures of his R factor (Restraint versus Rhathymia) and S (Sociability) factors. To Guilford, R was the true measure of Extraversion. (Using Guilford's rotations of the Eysenck items, and referring to the Eysenck and Eysenck 1969 analysis, the highest loading items on the R scale are 22, 40, 14, 50 and 35, Table 1). Although it is clear that the items used to measure E range across 90 degrees it is also the case that most of the items were within 30 degrees of the central Extraversion factor (H.J. Eysenck and S.B.G. Eysenck, 1969; S.B.G. Eysenck and H.J. Eysenck, 1969).

Until about 1975, Impulsivity and Sociability were seen as the defining components of Extraversion. This was made particularly explicit in a genetic analysis of the heritabilities of the two sub-scales from the EPI as well as the combined Extraversion factor (Eaves and Eysenck, 1975). While both Imp and Soc had roughly equal heritabilities (≈.6 when correcting for unreliability), and there was a reliable genetic component to their intercorrelation, there was a larger environmental component to the phenotypic correlation. This result led Eaves and Eysenck (1975) to suggest that the unitary nature of E at the phenotypic level was more strongly due to environmental rather than genetic factors.

A second influential model of the biological basis of personality that emphasized impulsivity rather than extraversion but that stayed in the same two-dimensional space was proposed by Gray (1972) who suggested a 45 degree rotation of the E/N axes to highlight anxiety (thought to be high N, low E) and impulsivity (high N, high E). Anxiety was hypothesized to represent a Behavioral Inhibition System (BIS) while impulsivity was hypothesized to represent the activation of a Behavioral Activation System (BAS). This model and its subsequent modifications and revisions (Gray, 1981, 1991, 1994) has become one of the standard biological models of personality (Revelle, 1995). Eysenck (1987) criticized the resulting emphasis upon the primary traits of anxiety and impulsivity (e.g. Barratt, 1987; Fowles, 1987; Revelle, 1987) and recommended focusing on the higher order dimensions of E and N.

Anticipating Gray's causal rotation of the E/N axes to represent Impulsivity and Anxiety, Kassenbaum, Couch and Slater (1959) showed that a two dimensional solution to the MMPI could be thought of in terms of I-E and S-N or rotated 45 degrees to emphasize impulsivity (versus intellectual control) and social participation (versus social withdrawal). This rotation emphasized the negative emotional consequences of high impulsivity.

Impulsivity and the P-E-N model

Further psychometric refinements of the EPI and the introduction of a Psychoticism scale led to the *Eysenck Personality Questionnaire* (EPQ; Eysenck and Eysenck, 1975) which was to measure the three factors of the Psychoticism-Extraversion-Neuroticism model. Although the EPQ was said to provide parallel scales of E and N with the EPI, in fact the E scale had a markedly different item content (Rocklin and Revelle, 1981). Seven of the nine impulsivity items in the EPI-E scale vanished, one (#39) stayed in the revised E scale, and one (#5) appeared on the new Psychoticism scale (Campbell and Reynolds, 1984). The situation did not change with the subsequent revision to the P scale and the release of the EPQ-R (Eysenck, Eysenck, and Barratt, 1985; Roger and Morris, 1991)

Contrary to following Guilford's advice to emphasize the unrestrained (impulsive) part of E, it seems that the Eysencks had decided to focus on the Sociability part of E and to claim that impulsivity was a component of P. A comparison of the EPI, EPQ and Guilford scales reported that while Extraversion as measured by the EPI correlates .58 with Guilford's Sociability (S) scale, EPQ-E correlates .81 with S. In opposite fashion, the EPI-E correlation with Guilford's Restraint-Rhathymia (R) scale of .61 drops to .41 for the EPQ-E scale. "...what Eysenck is

currently referring to as Extraversion is quite similar to what Guilford calls Social Activity and has only a weak relationship with what Guilford calls Introversion-Extraversion" (Campbell and Reynolds, 1984, p 316; see also Amelang and Ullwer, 1991). The importance of this change in the salience of the traits of sociability and impulsivity in the meaning of the "type" of extraversion may be seen in their differential pattern of correlations with preferences for cooperative and competitive activities (Wolfe and Kasmer, 1988).

In addition to the development of measures of PEN, efforts were made to develop supplementary items to measure Impulsivity. Multiple revisions of an expanded impulsivity scale were developed, the best known two of which were the I_5 (S.B.G. Eysenck and H.J. Eysenck, 1978) and the I_7 (S.B.G. Eysenck et al. 1985) Factor analyses of these scales showed that impulsivity was factorially complex with usually about 4 sub factors. Narrow impulsiveness, non-planning, liveliness, and risk taking scales were found to be reliable and moderately correlated. Just as each of these four sub scales have different patterns of correlations with PEN (mainly positively correlated with P and E with narrow imp also correlating with N) so did they have different relationships with performance measures. The move towards psychometric refinement did not necessarily lead to higher predictive validities. In a review of the relationship of impulsivity to conditioning Frcka and Martin (1987) conclude that the narrow impulsivity items from the EPI show a more consistent pattern of interactions with stimulus patterns than do the revised scales found on the I_5 or I_7.

Alternative measures of impulsivity

An unfortunate tendency in personality research is to develop new scales to measure old constructs. One reason for this is psychometric refinement, another is for more precise theoretical specification of constructs. Perhaps the largest is to stamp one's individuality (and scale?) on one's research. Such multiplicity of scales can lead to confusion as identical constructs are assessed with different scales or as different constructs are measured by scales with similar labels. Just as personality scales have proliferated in other areas, so have they in impulsivity research.

Many measures of impulsivity, from Murray's original explorations of impulsion (1938), to Guilford's dimensions of temperament (Guilford and Zimmerman, 1949), to Eysenck (1956) to Zuckerman (1994) ask variations on the basic self descriptive items "are you an impulsive person" and "do you do and say things without stopping to think" (Table 2). Variations on these items emphasize motoric, cognitive, and affective impulsivity as part of a general action orientation (Barratt, 1987; Barratt and Patton, 1983). The Barratt scales are highly correlated with the impulsivity scores from the I_7 and the structure of the pooled items suggests dimensions of rapid decision making and lack of foresight (Luengo, Carrillo-de-la-Peña, & Otero, 1991). Rating scales for children and self report inventories for adults were developed to assess the development of four temperaments, including impulsivity (Buss and Plomin, 1975). The impulsivity scale of the EASI (Emotionality, Activity, Sociability, Impulsivity) had four components, reflecting differences in inhibitory control, decision time, sensation seeking, and persistence. The Impulsivity scale of the Karolinska Scales of Personality included items emphasizing non-planning, rapid decision making, and carefree behavior taken from Guilford and Barratt (Schalling & Åsberg, 1985; Schalling, Edman and Åsberg, 1983). As would be expected given the similar source of items, the KSP-Imp scale is highly correlated with the EPI-imp scale. A scale composed of protypical acts of impulsivity correlates with EPQ-E and N as well as other standard measures of impulsivity (Romero, et al., 1994).

Insert Table 2 about here

Behaviorally, impulsivity as contrasted to reflection is said to result in rapid but inaccurate performance on a visual perception task (Kagan, 1966). However, scores on the Matching Familiar Figures Test show low correlations with most self report measures of impulsivity (Gerbing, Ahadi, & Patton, 1987; Helmers, Young & Pihl, 1995). Rather than

reflecting an overall difference in speed of response, impulsivity as indexed by the combination of high Neuroticism and high Extraversion (i.e., impulsivity as specified by Gray, 1972) leads to an inability to change the speed of response when told to draw a figure as slowly as possible (Bachorowski and Newman, 1985, 1990). That is, impulsivity is an inability to inhibit responding rather than just a fast rate of responding.

When working on simple cognitive tasks, faster performance usually results in a higher error rate. The appropriate rate of performance represents a balance between the rewards for the number of problems that are correct and the penalty for incorrect answers (Revelle, 1986). More impulsive subjects are more likely to adopt a style of faster responses and a higher error rate than are low impulsives (Dickman and Meyer, 1988; Rawlings, 1984). Moreover, when considering the relationship between speed of processing and the resulting error rate, two components of impulsivity can be identified (Dickman, 1990). Functional impulsivity is associated with rapid responses when they are appropriate while dysfunctional impulsivity seems to be an inability to adapt to an optimal response rate (Brunas-Wagstaff, Bergquist and Wagstaff, 1994; Dickman, 1990). Functional impulsivity is positively related to EPQ-E and P and negatively to EPQ-N while dysfunctional impulsivity is more related to E and P but not to N (Brunas-Wagstaff, et al., 1995). Dysfunctional impulsivity is more related to EPI-Imp and the Barratt Impulsivity Scale than is functional impulsivity (Dickman, 1990).

The location of impulsivity in the five dimensional models known variously as the "Big 5" (John, 1990; Goldberg, 1990), the "Five Factor Model" (Costa and McCrae, 1992), and the "alternate Big 5" (Zuckerman et al., 1993) varies by model specification and theorist. Although showing that EPI-soc and EPI-Imp were strong markers for extraversion in the extended NEO personality inventory, (McCrae and Costa, 1985), later development of the NEO located impulsivity as a facet of neuroticism that was equally correlated with E and N (Costa and McCrae, 1992). Other markers for impulsivity were correlated with (non) Conscientiousness, Extraversion, and Openness (Costa and McCrae, 1992). Within the lexical tradition of the "Big 5" impulsivity is seen as a mixture of (non)Conscientiousness and (non) Emotional stability (Hofstee, de Raad & Goldberg, 1992). Impulsivity in adolescence is seen as representing non conscientiousness and may be assessed using ratings adapted from the Childs California Q Sort (John et al., 1994).

At the scale level, Parker, Bagby, and Webster (1993) report one, two and three dimensional solutions to impulsivity measures from the Personality Research Form (PRF: Jackson, 1984), the Multidimensional Personality Questionnaire (MPQ: Tellegen, 1982, 1985), and the Guilford-Zimmerman Temperament Survey (GZTS: Guilford and Zimmerman, 1949). The factors of PRF impulsivity, MPQ cautious and methodical, and GZTS carefree, serious minded, and spontaneous are correlated and themselves are well fit by a two factor solution of cautious versus spontaneous and methodical versus disorganized (Parker et al. 1993). In a joint analysis of the EPQ, the I_7, and a German version of Cloninger's Tridimensional Personality Questionnaire (Cloninger, 1987), Impulsivity from the I_7 loads heavily on a factor defined by EPQ-E, TPQ-Novelty Seeking and TPQ-Reward Dependence (Weyers, Krebs, and Janke, 1995). As would be expected by Gray's model, EPI-Imp has higher corrations with Negative Affect than Positive Affect, a pattern that is the reverse of the correlations of EPI-Soc with affect (Emmons and Diener, 1986). This pattern of relationships interacts with neuroticism such that for high neurotics impulsivity and sociability are strongly related to positive affect, while for low neurotics impulsivity is equally related to positive and negative affect (McFatter, 1994).

Although analyses of the many separate scales of impulsivity indicate it is a multi-dimensional construct, a clear demonstration of this comes from an examination of the multivariate structure of a pooled set of 378 items taken from the existing impulsivity scales and measures of Barratt, Cattell, Eysenck, Guilford, Jackson, Kagan, and Zuckerman (Gerbing, et al. 1987). From this large set of items, 15 oblique first order factors and three broad and

correlated second order factors were identified. From the 12 first order factors of self report (impulsive, energetic, quick decision making, thrill seeking, avoiding planning, impulsive purchases, unreflective, avoids complexity, distractible, restless, impatient, and happy go lucky) three second level factors of spontaneous, not persistent, and carefree were formed.

Impulsivity in children and adults

Whether because of genetic effects (Eaves and Eysenck, 1975; Tellegen et al., 1988) or of the complex interplay of early temperament shaping the subsequent environment (Caspi, 1993; Derryberry and Rothbart, 1988), impulsive children tend to be more impulsive adults (Caspi and Silva, 1995; af Klinteberg, Magnusson, & Schalling, 1989). Childhood impulsivity is of central concern to theories of delinquency (John et al., 1994) and Attention Deficit--Hyperactivity Disorder (Barkley, 1997; Douglas, 1972) but until recently there has been little contact between theories of child and adult impulsivity. A few theoretical discussions of ADHD consider the inability to sustain attention as a sign of low arousal that results in a need for stimulation (Zentall and Zentall, 1983), with some awareness of the adult literature on arousal seeking (Eysenck, 1967) and stimulation seeking (Zuckerman, 1995) and more recent theories of temperament have started to integrate the structure of childhood temperament with adult personality structure (Eysenck, 1991b, 1994; Halverson, Kohnstamm and Martin, 1994; Rothbart, 1991; Strelau, 1991; Strelau and Angleitner, 1991). A commonly used measure of reflection vs. impulsivity with children and adults is the Matching Familiar Figures Test (Kagan 1966; Messer, 1976) that has low to zero correlations with paper and pencil measures of impulsivity (Gerbing et al., 1987; Helmers et al., 1995). Ratings of childhood temperament using the EASI (Buss and Plomin, 1975) or Q sort methodology show more favorable promise (John et al., 1994).

Impulsivity and arousal

For many of us interested in the relationship of personality to individual differences in cognitive performance, the theoretical framework proposed in the *Biological Basis of Personality* (Eysenck, 1967) acted as a navigational map for our explorations (Revelle, 1995). Although framed in terms of extraversion rather than impulsivity, the arousal model provided a common starting point. That much of the subsequent research involved impulsivity rather than extraversion is a tribute to the theoretical richness of the original model and the programmatic research that Eysenck inspired. The basic assumptions were 1) introverts are more aroused than extraverts; 2) stimulation increases arousal; 3) arousal is curvilinearly related to performance; 4) the optimal level of arousal for a task is negatively related to task difficulty; and 5) arousal is curvilinearly related to hedonic tone. Assumption 1 was based upon many studies associating EPI-E with (low) physiological arousal (Eysenck, 1967); Assumptions 3 and 4 were based upon the Yerkes-Dodson Law (Yerkes and Dodson, 1908) and subsequent support for it by Broadhurst (1959). Assumption 5 was founded on Berlyne's discussion of curiosity and arousal (1960). Based upon assumptions 1-4, it can be predicted that introverts should perform better than extraverts under low levels of stimulation but should perform less well at high levels of stimulation. Similarly, assumptions 1, 2, and 5 lead to the prediction that extraverts should seek out more stimulation than do introverts.

As the Eysencks tended to emphasize impulsivity in the PEN model as part of the P scale, and to redefine the measurement of E within the EPQ, a number of reanalyses of prior relationships of extraversion with behavioral, physiological and cognitive measures started to appear. Frequently, what had previously been reported as relationships between extraversion and arousal were found to hold for the EPI-E scale but not for the EPQ-E scale and in fact to hold for the EPI-Imp but not the EPI-Soc sub scales of the EPI.

EEG alpha activity shows a complex relationship with extraversion. Under moderately stimulating conditions, extraverts are less aroused than introverts (Gale, 1981) although this effect seems to be due to impulsivity (O'Gorman and Lloyd, 1987; Stenberg, 1992, 1994) it is still a weak relationship (Matthews and Amelang, 1993).

Impulsivity is related to the augmentation of the evoked potential response, at least when recordings are taken at the vertex and frontal locations (Carrillo-de-la-Pena and Barratt, 1993). This result is consistent with prior findings relating ERP augmentation to sensation seeking and disinhibited behavior (Barratt et al., 1987) and demonstrates the need for careful parametric specification of recording sites.

Impulsivity and caffeine induced arousal have cross-over interactive effects on skin conductance measures of arousal such that with placebo low impulsives have higher SCL than do high impulsives but although both groups increase with caffeine, the high impulsives now have higher levels of SCL (Smith, Rypma and Wilson, 1981). This effect was not found for measures of sociability.

Impulsivity and stimulation preference

A conclusion from the Biological *Basis of Personality* (Eysenck, 1967) is that introverts are chronically more aroused than are extraverts. This, with the assumption that there is an optimal level of stimulation leads to the prediction that extraverted behavior represents a greater stimulus hunger on the part of the less aroused extraverts. In a reanalysis of a previous result that had shown extraverts prefer to study in noisier conditions than introverts, Campbell (1983) found that this effect was due to impulsivity rather than to sociability. In a further analysis of the relationship of personality to tolerance for noise, Campbell (1992) found that when controlling for neuroticism there was a stronger effect for impulsivity than for sociability. Campbell and Heller (1987) found that both sociability and impulsivity related to Zuckerman's sensation seeking scale and that sociability had much higher correlations with the Meyer-Briggs Temperament Inventory Introversion-Extraversion measure than did impulsivity. Presumably reflecting a need for stimulation, more impulsive athletes prefer "explosive" sports while less impulsive athletes prefer "endurance" sports (Svebak and Kerr, 1989).

An important behavioral finding is the greater number of traffic violations and accidents for high impulsives than for low impulsives (Loo, 1979). In an examination of preference for bright (red, yellow) versus dull (blue, green) colors, Zuber and Ekehammar (1988) found that impulsivity interacted with time of day such that high impulsives preferred the bright colors in the morning but not in the evening, while low impulsives preferred brighter colors later in the day. Such an interaction of impulsivity with time of day in preferences is consistent with the finding that EPI-imp is more correlated than is EPI-Soc with preferred time of day for rising and retiring (morningness-eveningness; Neubauer, 1992).

The association of impulsivity with sensation seeking has led to alternative factor analytic rotations of three and five dimensional solutions for personality taxonomies with "impulsive-unsocialized sensation seeking" proposed as one of the fundamental dimensions of personality (Zuckerman, 1994; Zuckerman et al., 1993). In several domains of risky behavior, high impulsives give lower estimates of personal risk and have higher rates of engaging in risky behavior than do low impulsives (Horvath and Zuckerman, 1993). Impulsivity as measured by the I7 in combination with markers for unsocialized sensation seeking discriminates between a group of prisoners and control and prosocial or risky sport enthusiasts (Gomà-i-Freixanet, 1995).

Impulsivity and Conditioning

An early demonstration of the importance of impulsivity and task parameters in conditioning was the finding that low impulsives showed more rapid eyeblink conditioning than did high impulsives under conditions of stimulation but that this effect reversed under higher levels of stimulation. (Eysenck and Levey, 1972). This effect did not hold for sociability. After several failures to replicate this result using broader measures of impulsivity, Frcka and Martin (1987) reported that impulsivity in the narrow sense (essentially the impulsivity items from the EPI) did interact with stimulus intensity but broader measures from the I_5 and

I7 did not. Their article is an excellent review of the problems encountered when presumed psychometric refinements lead to experimental difficulties.

Several tests of Gray's hypothesis (1982, 1987, 1990) that impulsivity is related to sensitivity to cues for reward and that anxiety is related to sensitivity to cues for punishment have used conditioning paradigms. In a go-no go discrimination task where type of response was crossed with rewards or punishments, impulsivity and anxiety interact to predict response frequency (Zinbarg and Revelle, 1989). Similar results showing that anxiety and impulsivity provide a better fit to conditioning data than do neuroticism and extraversion have been reported by Corr, Pickering and Gray (1995) and by Diaz and Pickering (1993) with negative results by Pickering, Diaz and Gray (1995).

Newman and his colleagues have tested Gray's hypothesis by using the combination of neuroticism and extraversion as a surrogate for impulsivity (Bachorwski and Newman 1985, 1990; Newman, 1987; Wallace and Newman, 1980). Note that although framed in terms of Gray's model of impulsivity and anxiety, tests of his theory using E+N are not direct tests of impulsivity.

Impulsivity and cognitive performance

In addition to predicting correlations of extraversion with biological markers of arousal and making the predictions that people who say they enjoy lively parties and doing things quickly without stopping to think actually do so, the *Biological Basis of Personality* made predictions that allowed for an integration of personality and experimental psychology. Applying assumptions 1-4 led to predictions of how extraversion would combine with situationally induced arousal to affect performance. Specifically, introverts were expected to perform better than extraverts in situations that induced low arousal but to perform less well in situations that induced high arousal.

Seeming support for this prediction was the finding that time pressure and caffeine induced arousal hinders the performance of introverts but facilitates that of extraverts on a test similar to the verbal portion of the Graduate Record Examination (Revelle, Amaral and Turriff, 1976). Introverts performed best under conditions of no time pressure and no caffeine and their performance deteriorated with the introduction of time pressure and deteriorated even more with the combination of time pressure plus 200 mg of caffeine. Extraverts, on the other hand, performed worst in the low stress condition and best in the time pressure plus caffeine condition. However, in a conceptual replication of this study using three rather than two levels of caffeine, these effects were only consistent for EPI-E and not for EPQ-E (Gilliland, 1976). The difference turned out to be that the effects were due to the impulsivity items on the EPI-E scale.

Subsequent investigation showed that while caffeine reliability increased GRE performance for high impulsives and hindered it for low impulsives these effects were only true in the morning and in fact reversed in the evening (Revelle, et al., 1980). In a set of five new experiments and reanalyses of the Revelle et al. (1976) and Gilliland (1976) experiments there was a consistent, although complex triple interaction of impulsivity, caffeine induced arousal, and time of day. The pattern with sociability was much less consistent.

In an independent replication and extension of these findings Matthews (1987) measured extraversion, impulsivity and sociability using scales from Cattell's 16PF and used self reported arousal rather than manipulated arousal. A triple interaction of impulsivity, self reported arousal, and time of day was remarkably similar to the Revelle et al. (1980) results: low aroused low impulsives did better than high aroused low impulsives or low aroused high impulsives in the morning but this result reversed in the evening. Subsequent investigations by Matthews and his colleagues have shown that the time of day by arousal by extraversion interaction is the prototypical result although the relative contributions of sociability and impulsivity seem to be inconsistent (Matthews, Davies and Lees, 1990; Matthews, Jones and

Chamberlin, 1989). Interactive effects of impulsivity, caffeine, and time of day also have been reported by Smith et al. (1991).

Besides demonstrating that the arousal effects previously attributable to extraversion were more likely to be associated with impulsivity, these results called into question the basic assumption that extraverts were in fact always less aroused than introverts. The time of day results suggested that stable arousal differences could not account for the greater stimulation seeking of impulsives and extraverts, for otherwise, why would not extraverts be introverts at night? (Note, however, that Larsen, 1985, reports that diurnal variation in measures of arousal to be more related to sociability than to impulsivity.)

Revising Eysenck's first assumption to be that 1a) low impulsives are more aroused than high impulsives and 1b) this relationship reversed in the evening led to a series of studies showing consistent patterns of impulsivity by caffeine induced arousal interactions (reviewed in Revelle, 1989). Caffeine interacts with memory load requirements on a proofreading task such that it facilitates performances for high impulsives but not for low impulsives when memory load is high (Anderson and Revelle, 1982). Caffeine facilitated performance on a complex visual scanning task for high impulsives but did not for low impulsives (Anderson and Revelle, 1983). In the morning, in a super span memory task that required sustained attention, high impulsives showed a bigger decline in performance across trials than did low impulsives and the decline in performance was minimized by caffeine (Bowyer, Humphreys, and Revelle, 1983). Although this result can be replicated in the morning, it reverses in the evening (Anderson and Revelle, 1994).

Concerned that the evidence for the Yerkes-Dodson Law was based upon aggregation of between subjects effects and might not hold within subjects, Anderson (1994) examined the effects of five levels of caffeine on simple and complex performance tasks for high and low impulsives. Consistent with prior studies, the between subjects data showed a quadratic effect (inverted U pattern) for the low impulsives and a linear effect (increasing pattern) for the high impulsives. Applying an elegant analysis to the within subject patterns, Anderson concluded that the inverted U pattern occurred at the individual level with a reliable frequency and was not an artifact of data aggregation.

Impulsivity is an important component of the model of how personality traits interact with situational states to affect cognitive performance outlined by Humphreys and Revelle (1984) and subsequent developments of that model (Anderson, Revelle and Lynch, 1989; Revelle, 1989, 1993; Revelle and Anderson, 1992; Revelle, Anderson and Humphreys, 1987). Impulsivity systematically interacts with time of day in its effects upon cognitive performance. The most parsimonious interpretation of these results is that low impulsives are more aroused than high impulsives early in the day but are less aroused than high impulsives in the evening.

The relationship of impulsivity to performance needs to be considered at multiple levels of analysis and not just in terms of the arousal mediated effects (Revelle, 1987). Perhaps because they do well in time stressed situations, or perhaps because they are more sensitive to cues for rewards than to punishments, impulsives are more likely to engage in behaviors that put them in highly arousing situations and to adopt lifestyles that are focused on rewards and not concerned with the possible negative consequences. Such stylistic choices are not directly arousal related but do lead to lifelong differences in preferences that are modified only slightly by moment to moment or day to day shifts in arousal. How differences in impulsivity affect performance is also a function of other personality traits and abilities. Intelligence and anxiety should act as control mechanism to moderate the quick tempo and reward sensitivity of the high impulsive. Less able and less anxious impulsives should be much more likely to exhibit the problematic behavioral disorders associated with impulsivity than will more intelligent and anxious impulsives.

Conclusions

Impulsivity has long been seen as an important component of individual differences. Its place in a multidimensional personality theory is, however, less clear. Although its location in personality space has moved from a central part of extraversion to a blend of neuroticism and psychoticism to a neglected part of the lexical description of personality, impulsivity seems to show strong biological and behavioral correlates. Is this because impulsivity is a blend of constructs, each of which separately has a biological basis or is impulsivity a surface marker for an underlying biological system. Only time will tell help us resolve this question, and only then if the high quality of psychometric and biologically driven research inspired by Hans Eysenck continues to examine this important domain.

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Table 1: Representative Impulsivity items taken from Murray (1938), Eysenck (1958) short form, the "dual nature" (Eysenck and Eysenck, 1963), and the EPI (Eysenck and Eysenck, 1964). Reversed items are marked with (R).

Item #	Item	Source
	I often act on the spur of the moment without stopping to think.	Murray
	I waste no time in asking for what I want.	Murray
	I often act impulsively just to blow off steam.	Murray
	I usually make a plan before I start to do something. (R)	Murray
	I do most things slowly and deliberately. (R)	Murray
	I am slow to decide on a course of action. (R)	Murray
B	Do you prefer action to planning for action?	Short Form
D	Are you happiest when you get involved in some project that calls for rapid action?	Short Form
H	Are you inclined to be quick and sure in your actions?	Short Form
14	Do you often act on the spur of the moment without stopping to think?	Dual Nature
22	Are you inclined to stop and think things over before acting?	Dual Nature
35	Would you describe yourself as an easy going person not concerned to be precise?	Dual Nature
36	Do you tend towards a rather reckless optimism?	Dual Nature
40	Are you given to acting on impulses of the moment which later land you in difficulties?	Dual Nature
50	Do you prefer action to planning for action?	Dual Nature
1	Do you often long for excitement?	EPI
3	Are you usually carefree?	EPI
5	Do you stop and think things over before doing anything? (R)	EPI
8	Do you generally do and say things quickly without stopping to think?	EPI
10	Would you do almost anything for a dare?	EPI
13	Do you often do things on the spur of the moment?	EPI
22	When people shout at you, do you shout back?	EPI
39	Do you like doing things in which you have to act quickly?	EPI
41	Are you slow and unhurried in the way you move? (R)	EPI

Table 2: Representative items from different components of impulsivity.

Author	Component	Example items
Barratt (1987)	Motoric	I do things without thinking.
	Cognitive	I make up my mind quickly.
	Non-planning	I plan trips well ahead of time. (R)
Buss and Plomin (1975)	Inhibitory Control	I have trouble controlling my impulses.
	Decision Time	I often act on the spur of the moment.
	Sensation Seeking	I generally seek new and exciting experiences and sensations.
	Persistence	Once I get going on something I hate to stop. (R)
Dickman (1990)	Functional Impulsivity	I don't like to do things quickly, even when I am doing something that is not very difficult. (R)
	Dysfunctional Impulsivity	Often, I don't spend enough time thinking over a situations before I act.
Eysenck and Eysenck (1977)	Narrow	Do you often buy things on impulse? Do you generally do and say things without stopping to think? Are you an impulsive person? Do you often do things on the spur of the moment? Do you get extremely impatient if you are kept waiting by someone who is late?
	Risk Taking	Do you enjoy taking risks? Would you do almost anything for a dare? Do you often long for excitement?
	Non-Planning	Do you like planning things carefully well ahead of time? (R). When buying things, do you usually bother about the guarantee? When you go on a trip, do you like to plan route and timetables carefully?
	Liveliness	Do you usually make up your mind quickly? Are you slow and unhurried in the way you move (R); Do you prefer to "sleep on it" before making decisions? Can you put your thoughts into words quickly?
Gerbing, Ahadi and Patton (1987)	Spontaneous	I act on impulse.
	Not Persistent	You have a habit of starting things and then losing interest in them.
	Carefree	I am happy-go-lucky.
Parker, Bagby & Webster	Cautious vs. Spontaneous	I think before doing something.
	Methodical vs. Disorganized	I am very serious minded. (R)
Schalling & Åsberg (1985)	Non-planning	Do you more often make up your mind quickly than working out a decision slowly and carefully?
	Rapid decision making	When I have to make a decision, I "sleep on it" before I decide. (R)
	Carefreeness	I take life easy.

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