

Extraversion

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For at least 2500 years, some people have been described as more bold, assertive and talkative than others. For almost equally long, this set of behaviors has been thought to have a biological basis and be socially important. Although our taxometric techniques have changed and our theories of biology are more advanced, the question of the causal basis as well as the behavioral consequences of the trait dimension that has come to be called extraversion-introversion¹ remains vitally important.

In general, there are at least three basic characteristics of extraversion that make it important to study. First, extraversion has emerged as one of the fundamental dimensions of personality (Costa & McCrae, 1992a; Digman, 1990; H. J. Eysenck & Himmelweit, 1947; Goldberg, 1990; Norman, 1963). As such, extraversion has the potential to explain the covariation of a wide variety of behaviors, which is one of the central concerns for the field of personality (Funder, 2001). Second, extraversion predicts effective functioning and well-being across a wide variety of domains (Ozer & Benet-Martinez, 2006) from cognitive performance (Matthews, 1992) and social endeavors (Eaton & Funder, 2003) to social economic status (Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). Third, extraversion predicts risk and also resilience for different forms of psychopathology (Trull & Sher, 1994; Widiger, 2005).

¹Although occasionally one will see extroversion-introversion, the preferred spelling in psychological research is extraversion-introversion. For purposes of brevity we refer to the bipolar dimension of introversion-extraversion by referring to just one end of it, extraversion.

The ABCDs of Personality

We previously have proposed that personality can be conceptualized as the coherent patterning over time and space of Affect, Behavior, Cognition, and Desire (Ortony, Norman, & Revelle, 2005; Revelle, 2008). We believe that this model can be applied to specific trait complexes such as extraversion and thus we structure this chapter around these four domains of effective functioning.

The remainder of the chapter is organized as follows. First, we present a brief history of the interest in extraversion. Second, we summarize taxometric approaches to the measurement of extraversion. Third, the main focus of the chapter is devoted to recent and current trends in research on extraversion, structured around the ABCDs of extraversion. Fourth, we offer directions for future research.

Extraversion from Theophrastus to Eysenck

Ancient history. Tyrtamus of Lesbos, known as Theophrastus for his speaking ability, (Morley, 1891), asked a fundamental question of personality theory that is still of central concern to us today:

Often before now have I applied my thoughts to the puzzling question – one, probably, which will puzzle me for ever – why it is that, while all Greece lies under the same sky and all the Greeks are educated alike, it has befallen us to have characters so variously constituted.

The characters of Theophrastus are often used to summarize the lack of coherence of early personality trait description, although it is possible to organize his “characters” into a table (Table 1) that looks remarkably similar to equivalent tables of the late 20th century (John, 1990; John & Srivastava, 1999). The taxonomy developed by Theophrastus used antiquated terms; however, it is easy to see that some of them bear close resemblance to the adjectives used in contemporary approaches to describing extraversion. Another noteworthy personality taxonomy that captured an extraversion dimension was the model of the four temperaments described by Hippocrates and Galen, which was later reorganized into two dimensions (changeability and excitability) by Wundt (Wundt & Judd, 1897). The choleric and sanguine temperaments can be characterized as being more changeable whereas the melancholic and phlegmatic temperaments are less changeable. The changeability dimension was later conceptualized as extraversion by Eysenck (H. J. Eysenck & Himmelweit, 1947; H. J. Eysenck, 1981). See Stelmack and Stalikas (1991) for a review. Presaging current efforts to explain personality dimensions, a physiological basis for the four temperaments was proposed (blood for sanguine, yellow bile for choleric, black bile for melancholic, and phlegm for phlegmatic). In contrast to the similarity of old and new taxometric approaches to extraversion, the contemporary physiological differences (Canli, 2004) thought to underlie extraversion differ quite dramatically from the bodily humors.

Table 1: The characters of Theophrastus and the adjectives of the Big 5 show remarkable similarity. Big 5 adjectives from John (1990). The characters of Theophrastus are from Jebb’s translation (1909).

Trait				
extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
talkative	sympathetic	organized	tense	wide interests
assertive	kind	thorough	anxious	imaginative
active	appreciative	planful	nervous	intelligent
energetic	affectionate	efficient	moody	original
-quiet	-cold	-careless	-stable	-commonplace
-reserved	-unfriendly	-disorderly	-calm	-simple
-shy	-quarrelsome	-frivolous	-contented	-shallow
-silent	-hard-headed	-irresponsible	-unemotional	-unintelligent
talker	anxious to please	-hostile	coward	-stupid
chatty	flatterer	-shameless	grumbler	-superstitious
boastful	-unpleasant	distrustful	mean	-boor
arrogant	-outcast	-avaricious	unseasonable	-gross
garrulous	-offensive	-reckless	feckless	ironical

Although people were recognized as falling at a certain level on behavioral dimensions resembling extraversion as far back as 2500 years ago, it was not until C.G. Jung (Jung, 1921/1971) that the names extraversion and introversion were brought into the popular terminology of psychology. However, Jung did not emphasize a continuous extraversion dimension but rather conceptualized extraverts and introverts as different types of people. For Jung, extraverts were more focused on the outer world and introverts on their own inner mentality. He also associated extraversion with hysteric disorders and introversion with what today would be called mood disorders. Although the credit is usually given to Jung for originating the modern name of extraversion, the less known but very important work of Gerard Heymans (H. J. Eysenck, 1992) had already identified extraversion more accurately as a dimension (rather than a type) along a continuum of “strong” and “weak” functioning. It is also Heymans whom we should credit for the integration of psychometric methods with experimental approaches to personality, and situating psychological research in the hypothetico-deductive method. Standing on the shoulders of Heymans and those who came before him, Hans Eysenck demonstrated the importance of extraversion as a fundamental dimension of personality in a series of experimental and taxometric studies in the late 1940s and early 1950s (H. J. Eysenck & Himmelweit, 1947; H. J. Eysenck, 1952) .

The Measurement of Extraversion

The descriptive tradition in personality, as mentioned before, has its roots in Theophrastus and Galen. In the twentieth century, psychologists began serious efforts to measure the major dimensions of personality, and all such efforts have identified extraversion as a major dimension.

Mid twentieth century taxonomies: The Giant Three

Eysenck was one of the first to try to describe the core features of the extraversion and developed scales to assess personality, the Maudsley Personality Questionnaire, MPQ, (H. J. Eysenck, 1959), the Eysenck Personality Inventory, EPI, (H. J. Eysenck & Eysenck, 1968), the Eysenck Personality Questionnaire, EPQ, (S. B. Eysenck & Eysenck, 1975), and the Eysenck Personality Profiler, EPP, (H. J. Eysenck & Wilson, 1991) Some of the items for the MPQ and EPI were adapted from Guilford which led to an interesting debate as to the proper structure of extraversion. The instrument Guilford developed to measure personality, the Guilford Zimmerman Temperament Survey, GZTS, (Guilford & Zimmerman, 1949), identifies a higher order factor called introversion-extraversion, which reflects a dimension similar to Jung's in that introversion is described by reflective behavior. However, the extraversion pole of this scale is similar to extraversion as measured by Eysenck's EPI, as extraverts are described as lacking restraint and exhibiting impulsive behavior. Another higher order factor identified by the GZTS is called social activity, which contains aspects similar to the sociability part of Eysenck's extraversion. Subsequent analyses of the structure of the EPI and the EPQ showed that the biggest difference is that extraversion in the EPI contains an roughly equivalent amount of sociability and impulsivity items, whereas the EPQ contains many more sociability than impulsivity items (Rocklin & Revelle, 1981).

Current taxonomies

Raymond Cattell laid the foundation for modern lexical analysis when he factor analyzed paragraph descriptors based on Allport and Odbert (1936)'s list of traits (extracted from an unabridged dictionary) to derive 16 primary personality factors (Cattell, 1946), five of which cluster together to form a higher order factor of extraversion (Cattell, 1957). The content of Cattell's extraversion contains aspects of Eysenck's, Gray's, and Guilford's conceptualizations of extraversion, as Cattell's extravert is described as highly impulsive, social, and ascendant.

Big Five. Following the lead of Fiske (1949) and Tupes and Christal (1961) on peer ratings, and his own work on peer ratings based on the paragraph descriptors of Cattell (Norman, 1963), what has come to be called the Big Five factors of personality were derived from a factor analysis of English adjectives taken from the dictionary by Warren Norman (Goldberg, 1990). These five factors, called Surgency (similar to extraversion), Agreeableness, Conscientiousness, Neuroticism, and Openness, were observed in the languages of

many different cultures (Goldberg, 1990). Many of the adjectives have high loadings on two (not one or three) factors (Hofstee, Raad, & Goldberg, 1992), so that pairs of the Big 5 dimensions have a circumplex structure. This structure is measured by the Abridged Big Five Circumplex (AB5C), which contains items that have a primary loading on one factor and secondary loading on a second one. In the AB5C, Surgency is described mainly by the disposition to engage in *approach behavior*.

Five Factor Model. Costa and McCrae's (Costa & McCrae, 1992a; McCrae & Costa, 1997) five factor model of personality (FFM) consists of personality dimensions similar to the Big 5 and also identifies extraversion as a primary factor. The FFM assumes a hierarchical structure with each higher order factor seen as the result of six lower order facets. In the case of extraversion the facets are Warmth, Gregariousness, Assertiveness, Activity, Excitement Seeking, and Positive Emotion. The FFM is primarily associated with the NEO-PI-R (Costa & McCrae, 1992a) and the NEO-FFI (Costa & McCrae, 1992a). The core feature of extraversion in the FFM is thought to be the disposition to engage in *social behavior*.

The smaller seven. Tellegen (1985) also took terms from the dictionary and subjected them to factor analysis; the resulting taxonomy of personality consisted of seven factors, five of which resemble the Big 5 and FFM, and two that reflect positive evaluation and negative evaluation. Tellegen (1985) divided extraversion into lower order facets, well-being, social potency, social closeness, and achievement, which are measured by the MPQ (Tellegen, 1982). In this taxonomy, *positive emotionality* constitutes the core of extraversion,

Socioanalytic Theory. Another personality theory with seven factors in which extraversion appears is Hogan (1982)'s Socioanalytic Theory. This theory differs from the other descriptive taxonomies in that, instead of viewing traits as entities within a person, they are instead aspects of a person's reputation. In this scheme, sociability and ambition serve as markers of social adaptation and form a higher order factor resembling extraversion. The causal mechanism thought to give rise to *sociability and ambition* are the evolutionary pressures "to get along" and "get ahead" (Hogan, 1982).

HEXACO. Sharing Socioanalytic Theory's emphasis on evolutionary adaptation is the HEXACO (X = extraversion) model of personality (Ashton & Lee, 2001), which adds honesty to the Big 5 factors. The core feature of extraversion is thought to be *active engagement in social endeavor*, which is assumed to be one of the common tasks for humans in evolutionary history (Ashton, Lee, & Paunonen, 2002). **The HEXACO model divides extraversion into four facets labeled Expressiveness, Liveliness, Sociability, and Social Boldness.**

Biological distinctions. Although there is a divide in the biological versus descriptive traditions, efforts to reconcile these views are emerging. DeYoung, Quilty, and Peterson (2007) and colleagues developed the Big Five Aspects Scales (BFAS), which measures the

lexically derived factors of personality using biologically informed theory. In the BFAS, extraversion is divided into two aspects which supposedly have different genetic underpinnings, *enthusiasm and assertiveness*. One advantage of the BFAS is that items are highly correlated within aspects, but only moderately correlated between aspects.

Summary: Measurement

The appearance of extraversion in lexically, behaviorally and biologically derived taxonomies is suggestive evidence that it is one of the most noticeable and important descriptors of personality. Although there are not as many inventories measuring extraversion as there are investigators, it sometimes seems that way (Table 2). Many of the early studies used scales made up of items of complete sentences created by the Eysencks (the MPQ, EPI, EPQ, EPP), but more recent studies have tended to use either the sentence format of the NEO-PI-R, NEO-FFI, or the adjectives of the Big Five markers (BFM) (Goldberg, 1992). With the release of the open source collaboratory, the International Personality Item Pool (IPIP) (Goldberg, 1999; Goldberg et al., 2006), which emphasizes phrases rather than sentences or adjectives, it is now possible to create scales targeted at all the other commonly used inventories or to create new scales such as the BFAS (DeYoung et al., 2007). A “consumer’s guide” comparing the IPIP to most of the larger inventories has also been published (Grucza & Goldberg, 2007).

Theoretical Approaches

It is obvious that conceptualizations of extraversion differ from investigator to investigator; however, because it seems nearly certain that one of the fundamental dimensions of human personality contains extraversion content, it is important to determine where this dimension has its basis. No two researchers did more to advance this cause than Hans Eysenck and Jeffrey Gray. We now review their seminal work and famous debate, and then we transition to contemporary evolutionary, neurological, and temperamental approaches to explaining extraversion.

Hans Eysenck

Hans Eysenck modernized the study of extraversion through both experimental and psychometric approaches. Eysenck long argued that the major dimensions of human personality have a biological basis. His first attempt to explain extraversion was based on the notions of excitation and inhibition (H. J. 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. The conditioning model underwent significant revision and was reformulated as the now famous arousal hypothesis of extraversion (H. J. Eysenck, 1967). The central tenet of arousal theory is that introverts have lower threshold for arousal in

Table 2: Commonly used inventories measuring extraversion

Inventory	Abbreviation	Author	Year
Abridged Big Five Circumplex	AB5C	Hofstee, de Raad, & Goldberg	1992
Big Five markers	BFM	Goldberg	1992
Big Five Inventory	BFI	John, Donahue, & Kentle	1991
Big 5 Aspect Scales	BFAS	DeYoung, Quilty, & Peterson	2007
Eysenck Personality Inventory	EPI	H.J. & S.B. Eysenck	1968
Eysenck Personality Questionnaire	EPQ	S.B. & H.J. Eysenck	1975
Eysenck Personality Profiler	EPP	H.J. Eysenck & G. D. Wilson	1991
Five Factor Non Verbal Personality Questionnaire	FF-NPQ	Paunonen and Ashton	2002
Guilford Zimmerman Personality Survey	GZTS	Guilford & Zimmerman	1949
HEXACO Personality Inventory	HEXACO-PI	Lee and Ashton	2004
International Personality Item Pool	IPIP	Goldberg	1999
Maudsley Personality Questionnaire	MPQ	H.J. Eysenck	1959
Multidimensional Personality Questionnaire	MPQ	Tellegen	1982
Neuroticism-extraversion-Openness Personality Inventory Revised	NEO-PI-R	Costa & McCrae	1992
NEO Five Factor Inventory	NEO-FFI	Costa & McCrae	1992
Riverside Behavioral Q-Sort	RBQ	Funder, Furr, & Colvin	2000

the ascending reticular activating system (ARAS) than extraverts. The ARAS is a feedback loop connecting the cortex to the reticular activating system. The beauty of the arousal theory of extraversion is that it led to two direct and testable hypotheses about performance differences between extraverts and introverts. First, from the Yerkes-Dodson “law” (Yerkes & Dodson, 1908), extraverts should outperform introverts in highly arousing situations (because extraverts should be less prone to overarousability) and introverts should outperform extraverts in low arousal situations (because introverts should be less prone to underarousability). For an elegant test of this hypothesis within subjects, see Anderson (1990). Second, based on Wundt’s notion that people try to maintain moderate arousal (Wundt & Judd, 1897), extraverts should, on average, respond more and faster than introverts (in order to increase their arousal) during performance tasks. Indeed, the explanation for extraverted behavior as arousal seeking was a compelling explanation for their the use of stimulant drugs (cigarettes), sexual activities, and social interaction.

Jeffrey Gray and Reinforcement Sensitivity Theory

Over the last 50 years, Eysenck’s hypotheses have generated thousands of studies yielding varying degrees of support (Matthews & Gilliland, 1999). More interesting and

Table 3: Representative Items from extraversion scales emphasize Affective and Behavioral aspects

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

more conducive to scientific progress than testing a single theory is when competing theories emerge. This happened when Jeffrey Gray proposed an alternative causal theory of extraversion, Reinforcement Sensitivity Theory (RST) (Gray, 1970, 1981, 1982). Based on animal research, the original formulation of RST postulated the existence of three separate neural systems underlying behavior: a) the Behavioral Approach System (BAS), b) the Behavioral Inhibition System (BIS), and c) the Fight-Flight System (FFS). The primary emphasis was on the effects of the BIS and BAS. Sensitivity of the BAS was thought to underlie trait impulsivity, and sensitivity of the BIS was thought to underlie trait anxiety. These traits were conceptualized as primary traits that together could explain Eysenck's higher order factor of extraversion. Eysenck's extraversion was thought by Gray to be Impulsivity minus Anxiety. Similar to Eysenck's theory, RST makes predictions about performance, but these predictions are more complicated and harder to generalize to human research because RST was founded on animal data. However, RST does make a straightforward predictions regarding learning and affect; because extraverts should be more sensitive to reward than introverts, extraverts should condition faster to rewarding stimuli and experience more positive affect than introverts.

Eysenck-Gray debate

Eysenck's and Gray's theories were at the forefront of research on extraversion for nearly thirty years, generating a wide range of studies employing various methodologies. An excellent review of the vast body of literature motivated by these theories is provided by Matthews and Gilliland (1999). Most of that review lies outside the scope of this chapter, but we do present a simplified summary of findings that have relevance to our previous discussion. Eysenck's early theory of conditioning has not received support, as both extraverts and introverts show conditioning advantages in different situations. Eysenck's arousal theory, however, has received a moderate amount of support as introverts have been shown to be more aroused than extraverts in general, although Revelle, Humphreys, Simon, and Gilliland (1980) suggest this might be true only in the morning. In support of Gray's theory, extraverts experience more positive affect than introverts; this finding has been one of the most robust in all of personality psychology (Lucas, Diener, Grob, Suh, & Shao, 2000). Also in support of Gray's theory, most research suggests that extraverts condition faster to rewarding stimuli (although Zinbarg and Revelle (1989) show complex interactions with anxiety). Since the time of the Matthews and Gilliland (1999) review, Gray's theory has undergone drastic revisions that are beyond the scope of this chapter (Corr, 2008; Gray & McNaughton, 2000; Smillie, Pickering, & Jackson, 2006; Smillie, in press). Eysenck and Gray were pioneers in the investigation of extraversion, and it is doubtless that their legacies will live on with new advances in biological theory about extraversion in the years to come.

Contemporary evolutionary, neurological, and temperamental
approaches

Research has sought to elucidate causes for the extraversion dimension at different levels of explanation. From the most distal to proximal explanations proposed for extraversion we address its evolutionary, neurological, and temperamental underpinnings, as we believe that understanding broad higher order traits such as extraversion require analysis at all of these levels.

Evolution and Genetics

It has been claimed that evolutionary theory must anchor personality theory, as Buss (1995) proposed that personality dimensions evolved to deal with domain specific tasks in the social environment. Two of the most important evolutionary tasks in Buss's view can be succinctly summarized as "getting along" and "getting ahead" (note the similarity to Socioanalytic theory). Based on the universality of these tasks, it is assumed that all humans developed behavioral approach and behavioral avoidance systems—behavioral approach we associate with the extraversion continuum.

In criticism of evolutionary theory of personality, Tooby and Cosmides (1990) argue that such between-person variations would not exist in characteristics under selective

pressure. In response, different explanations for between-person variations have been put forward. Individual variation in approach behavior (and thus extraversion) could have arisen out of the variety of social niches that people can occupy (Buss, 1995). There are a variety of ways for people to navigate the social environment, and different levels of personality traits reflect different ways to deal with social environment (MacDonald, 1995). Nettle (2006) points out two general flaws with Tooby and Cosmides (1990) argument. First, if a characteristic is determined from multiple genes (as it is assumed for personality traits), it will take an incredibly long time to minimize variations in such constructs. Second, many adaptations along the same dimension can be equally beneficial. Trade-offs can occur at different levels on the extraversion continuum (Nettle, 2005, 2006). At high levels of extraversion, people might be more likely to mate and succeed socially, but they might also be more likely to die from risky behavior. At low levels of extraversion, these probabilities are reversed. Nettle (2005) cleverly addressed the common criticism that psychological theories based on evolution cannot be tested by actually testing and finding support for the trade-off hypothesis for extraversion (as measured by IPIP items). Extraverts do have more mates but also die earlier than introverts (Nettle, 2005).

As would be expected for traits with evolutionary bases, and as is true for most personality traits, extraversion is moderately heritable, $h^2 = .45-.50$, with little if any shared environmental influence (Bouchard & Loehlin, 2001). Support for extraversion as having a substantial genetic basis is also garnered from the finding that extraversion can be identified in many animal species; additionally, each FFM facet of extraversion displays moderately high heritability, and the relationships between extraversion facets are largely accounted for by genetic factors (Jang, Livesley, Angleitner, Riemann, & Vernon, 2002). There is some evidence that heritability for extraversion declines with age (Bouchard & Loehlin, 2001), which logically means that the environment becomes a more important source of extraversion variation as people grow older. Finding that extraversion is heritable is the first step in uncovering specific genetic pathways that influence extraversion's development. Further progress in this aim now being made as research has identified genes that account for between-person variation in extraversion, one likely candidate being ADH4 (Luo, Kranzler, Zuo, Wang, & Gelernter, 2007).

Extraversion and brain function/structure

Genes do not act directly on behavior; genetic effects are mediated by brain function and structure (Revelle, 1995). Eysenck and Gray were the first to detail complex theories about how this might be the case for extraversion, and recent empirical investigations continue to advance our understanding of extraversion's neurobiological basis.

The dopaminergic hypothesis of agentic extraversion. Recently, Depue (1995) developed a novel theory for a subcomponent of extraversion labeled "agentic extraversion" because it encompasses the achievement, ascendance, and achievement aspects of extraversion.

sion (Depue & Collins, 1999)². Depue's theory closely resembles Gray's original RST in that a Behavioral Facilitation System (BFS), the function of which is to increase the salience of positive stimuli, is thought to be a causal basis for agentic extraversion (Depue, 1995; Depue & Collins, 1999). Depue's model of behavioral facilitation is a threshold model in that dopamine must reach a certain level for approach behavior to be elicited. Thus, approach behavior is thought to depend on one's tonic level of dopamine as well as one's phasic level (Depue, 1995). At present, evidence for this model is inconsistent. The first support for the theory was that extraversion as measured by the MPQ (Tellegen, 1982) correlated with prolactin indicators of dopamine functioning in 11 women (Depue, Luciana, Arbisi, Collins, & Leon, 1994); this finding was subsequently replicated with a larger sample (Depue, 1995). Other studies do not support Depue's theory. For example, Fischer, Wik, and Fredrikson (1997) measured extraversion with a German adaptation (Ruch & Hehl, 1989) of the EPQ-R (S. B. Eysenck, Eysenck, & Barrett, 1985) and found that extraversion was negatively correlated with subcortical brain activity in the caudate nucleus and the putamen, areas that have high concentrations of dopamine terminals. As it stands, the dopaminergic hypothesis provides an exciting avenue to pursue the biological basis of agentic extraversion. Newly developed ways to measure dopaminergic functioning non-invasively, such as with EEG, may serve to increase the rate at which research determines the relationships between agentic extraversion and dopamine (Wacker, Chavanon, & Stemmler, 2006).

Neurophysiological and neuroanatomical underpinnings of extraversion. It is clear from the measurement section of this paper that extraversion has a positive affect component, but the biological mechanisms underlying this association are not well known. In an excellent review, Canli (2004) describes neuroimaging studies conducted in the aim of elucidating the extraversion - positive affect association. Across a wide range of tasks, fMRI analysis revealed that extraversion as measured with the NEO-PI-R was associated with greater activation in numerous areas of the brain (amygdala, caudate, medio-frontal gyrus, right fusiform gyrus) when positive stimuli, but not negative stimuli, were presented. One important implication of these studies, noted by Canli (2004), is that personality factors like extraversion are likely to be widely distributed in the brain.

Recent studies have added to our knowledge about the activation patterns that correlate with extraversion and sought to explain such patterns. Extraversion measured with the EPQ has been associated with activation in the lateral pre-frontal cortex, lateral parietal cortex, and right anterior cingulate cortex; each of these brain areas is associated with task-focused self-control and discrepancy detection (Eisenberger, Lieberman, & Satpute, 2005). Haas, Omura, Amin, Constable, and Canli (2006) determined that the NEO-PI-R facets of excitement seeking and warmth accounted for the association noted above between

²The neurobiology of Depue's "affiliative extraversion", encompassing warmth and social closeness, has only recently received research attention but is generally thought to be based on opiate functioning (Depue & Morrone-Strupinsky, 2005)

extraversion and anterior cingulate cortex activity (Canli, 2004; Eisenberger et al., 2005). Two other novel findings from this paper were that extraversion predicted functional connectivity to the anterior cingulate, and that this association was mediated by the facets of warmth, gregariousness, and positive emotions. The studies discussed up to this point have focused on predicting brain activity during task-engagement. Deckersbach et al. (2006) recently extended these findings by showing that, at rest, extraversion measured by the NEO-FFI (Costa & McCrae, 1992b) is associated with greater activity in the orbitofrontal cortex, which might play a part in shifting attention to positive incentives.

Differences in brain structures are also associated with extraversion, and such differences may have diverse implications for psychopathology, learning, and behavior. MRI studies have shown that NEO-PI-R extraversion is positively correlated with gray matter in the left amygdala (Omura, Constable, & Canli, 2005); as reductions in amygdalar gray matter predict depression, this finding may suggest that extraversion is a protective factor against depression (Omura et al., 2005). Extraversion (as measured by the NEO-FFI) and thickness of orbitofrontal cortex are associated, and extinction of fear retention mediates the path from orbitofrontal thickness to extraversion (Rauch et al., 2005), suggesting that brain structure influences extraversion by influencing learning processes. One way that brain structure relates to specific components of extraverted behavior is illustrated by the finding that extraversion (measured by the NEO-FFI) is inversely related to thickness of the right anterior pre-frontal cortex and the right fusiform gyrus; low thickness in these areas has been suggested as underlying impulsive and disinhibited behavior (Wright et al., 2006).

Temperament

It is clear that extraversion is associated with structure and function across many areas of the brain; that extraversion has a strong biological component suggests that precursors of trait extraversion should appear early in development. The study of temperament shows this to be the case. Temperament refers to individual differences in reactivity and self-control that arise from a constitutional basis (Durbin, Klein, Hayden, Buckley, & Moerk, 2005; Rothbart, 1981). A temperament dimension of extraversion/positive affect (PA) has been identified in infants as young as three months, in middle childhood, and even into adulthood (Rothbart, Ahadi, & Evans, 2000). As its name implies, this dimension shares characteristics with the extraversion personality trait. For example, one study that factor analyzed lower order components of temperament found that a higher order extraversion/PA factor included sociability and positive affect components, and it also consists of regulatory components such as inhibitory control (Evans & Rothbart, 2007). The inclusion of regulatory aspects makes temperamental extraversion/PA especially interesting to study in the context of dynamic cognitive and behavioral processes (Evans & Rothbart, 2007). In one of the few studies to use a dynamic design, Derryberry and Reed (1994) found that adult extraversion/PA temperament (measured with a short version of the EPQ) predicted difficulty in shifting attention away from positive stimuli, but not neg-

ative stimuli. It is interesting to note that the previous findings harken back to notions from Eysenck's and Gray's conceptualizations of extraversion. Inhibitory control overlaps considerably with Eysenck's emphasis on the impulsivity component of extraversion (H. J. Eysenck, 1967), and Reinforcement Sensitivity Theory (Gray & McNaughton, 2000) explicitly predicts that extraversion should relate to attentional biases toward positive stimuli and approach behavior.

Extraversion and the ABCDs

The previous sections can be thought of as the ontogeny of a trait, starting off as genes, developing into biological structures and systems, and then being expressed early in life as temperament. We view the fully developed, higher order traits like the Big Five or Giant Three as characteristic patterns of affect, behavior, cognition, and desire.

How do extraverts feel?

It is well established that extraverts feel higher levels of positive affect than introverts (Costa & McCrae, 1980; Lucas & Baird, 2004; Watson & Clark, 1992). The relationship between trait extraversion and trait positive affect has emerged in many cultures with many different methods (Lucas & Baird, 2004), with the average correlation found to be around $r = .40$ (Lucas & Fujita, 2000). Extraversion predicts positive affect across three time frames; not only do measures of trait extraversion predict trait positive affect, but trait extraversion also predicts aggregated momentary positive affect (Costa & McCrae, 1992a; Spain, Eaton, & Funder, 2000) as well as single ratings of current positive affect (Lucas & Baird, 2004; Uziel, 2006). This means that extraverts are happier than introverts in general, over short time frames, and even in the moment.

It has even been proposed that extraversion is at its core the tendency to experience positive affect (Watson & Clark, 1997), and there is some evidence to support this claim. The covariation of extraversion components is accounted for by positive affect; once positive affect is removed, the other components of extraversion do not correlate with each other. A similar finding reported recently is that extraversion facets reflecting reward sensitivity load on a higher order extraversion factor that accounts for the correlations between the other facets of extraversion (Lucas & Baird, 2004). Not only does trait extraversion predict trait positive affect, but both both traits predict similar outcomes, such as social activity, leadership, and number of friends (Watson & Clark, 1997).

The evidence linking extraversion and positive affect is very strong; however, at least three findings suggest that it would be rash to conceptualize extraversion and positive aspects as redundant constructs. First, they share only about 30% of the total variance between constructs (Watson, 2000). Second, behavioral content is better represented than positive affect in measures of extraversion (Pytlik Zillig, Hemenover, & Dienstbier, 2002). Third, a study by Ashton et al. (2002) used the same method as in Lucas et al. (2000)

and showed that the tendency to behave in ways that attract social attention accounts for the common variance among NEO-PI-R extraversion facets.

Extraversion and positive affect might not be the same construct, but the robust relationship between the two calls for explanation. The explanations that have been offered can be grouped into those postulating either a primarily structural or instrumental basis for the relationship. A structural explanation means that extraverts possess some quality or characteristic that leads them to experience more happiness than introverts. The general structural explanation is described by the affect-threshold model (Rosenberg, 1998), which can be divided into the affect-level model (Gross, Sutton, & Ketelaar, 1998) and the affect-reactivity model (Larsen & Ketelaar, 1991; Strelau, 1987). The affect-threshold model states that extraverts have a lower threshold for experiencing positive affect than introverts; that is, it should require less positive stimulation to elicit positive affect from extraverts than introverts. This model is general in that it does not distinguish between two ways that equal positive stimulation could lead to more positive affect for extraverts. The first way is described by the affect-level model (Gross et al., 1998), which states that extraverts, because they are closer to experiencing positive affect than introverts at baseline, require relatively less positive stimulation to feel good. The second way is described by the affect-reactivity model, which states that extraverts and introverts could feel the same amount of positive affect at baseline, but that extraverts react more strongly to positive stimuli than introverts. It is clear that the affect-reactivity has its roots in Reinforcement Sensitivity Theory (Corr, 2008; Gray, 1970, 1981, 1982).

Testing the two models requires identifying circumstances under which they make conflicting predictions. In the affect-level model, it is assumed that extraverts have a higher tonic level of positive affect, thus it predicts that extraverts should be happier than introverts in negative, neutral, and positive valence situations. The affect-reactivity model assumes that extraverts and introverts have similar tonic levels of positive affect, but that extraverts react more strongly to positive stimuli; thus it predicts that extraverts should be happier than introverts in positive valence situations only. Gross et al. (1998) found support for both models in their seminal investigation, manipulating situation valence with positive, neutral, and negative film clips. Recently, a meta-analysis of six studies revealed that the accuracy of each model depends on situational properties (Lucas & Baird, 2004). In support of the affect-level model, extraverts were happier in neutral situations - in support of the affect-reactivity model, extraverts' activated positive affect (e.g., awake, alert), but not pleasant positive affect (e.g., pleasant, good) was more reactive to positive stimulation. An even more complex picture emerges when the interaction of extraversion with Neuroticism on affective reactivity is taken into account, as emotionally stable extraverts react to positive stimuli more strongly than neurotic extraverts (Rogers & Revelle, 1998).

Another class of explanations for the extraversion - positive affect relationship posits instrumental origins. Instrumental explanations assume that the relationship between extraversion and positive affect is based on differences in what extraverts and introverts do in their daily lives.

Sociability theory (Watson, 1988; Watson, Clark, McIntyre, & Hamaker, 1992) posits both instrumental and structural explanations for the extraversion - positive affect relationship. Sociability theory's intuitive instrumental hypothesis is that extraverts are happier than introverts because they engage in more social activities; the complementary structural explanation is that extraverts enjoy social activities more than introverts. Some evidence has been found in support of Sociability theory, as Argyle and Lu (1990) found that extraverts participate in more social activities than introverts, and that amount of social activity partially mediated the extraversion - happiness relationship. Evidence that contradicts sociability theory. Pavot, Diener, and Fujita (1990) found that extraverts and introverts spend the same amount of time in social situations, and that introverts experience just as much happiness as extraverts in social situations. It has been found that extraverts are happier than introverts across a variety of situations both of a social and nonsocial nature (Diener, Sandvik, Pavot, & Fujita, 1992).

The between-person extraversion - positive affect relationship has recently been extended to existing within-persons as well. A within-person relationship means that an individual's momentary positive affect depends on momentary levels of extraversion, or *state* extraversion (Fleeson, Malanos, & Achille, 2002). Fleeson et al. (2002) found that all participants, regardless of trait level extraversion, were happier the more extraverted they acted. Recent studies continue to support the strong link between state extraversion and state positive affect. Participants felt more positive affect in experiments where participants were instructed to act extraverted, suggesting that state extraversion causes state positive affect (McNiel & Fleeson, 2006). Additionally, state extraversion was found to mediate the relationship between approach goals and state positive affect (Heller, Komar, & Lee, 2007).

How do extraverts behave?

In the field of Personality psychology, primary importance has been placed on explaining behavior (Funder, 2001). According to Funder, despite the importance, little research has actually been conducted in this aim; Funder (2001) even explicitly offered extraversion as an example of a trait that has not been investigated in relationship to actual behavior. However, this seems to be a very narrow definition of behavior restricted to laboratory situations for it ignores the earlier work of Eysenck who examined the factor structures of behavioral observations (H. J. Eysenck & Himmelweit, 1947), and the even earlier work of Heymans (H. J. Eysenck, 1992), but it would include the German Observational Study of Adult Twins (GOSAT) project of Borkenau, Riemann, Angleitner, and Spinath (2001) and Antill's observational study of talking behavior as a function of extraversion and group size (Antill, 1974). Recently, research has begun to address the important goal of elucidating the content of extraverted behavior.

As it is expected that personality traits manifest themselves in behavior (Funder, 2001), the most straightforward hypothesis (relating to extraversion) resulting from this expectation is that trait extraversion should at least predict aggregate state extraversion.

What little research exists suggests that individuals with higher levels of trait extraversion are indeed predisposed to enact more extraversion states (Heller et al., 2007; Schutte, Malouff, Segrera, Wolf, & Rodgers, 2003). Research on how extraversion relates to more discrete categories of behavior is also lacking, which motivated the development of the Riverside Behavioral Q-Sort (RBQ) as a remedy (Funder, Furr, & Colvin, 2000). The RBQ contains a list of behavioral items that can be rated for how much they describe a participant's behavior in social interactions. In a study using the RBQ, extraversion measured with the NEO-PI (Costa & McCrae, 1985) predicted behaviors that can be characterized as energetic, bold, socially adept, and secure (Funder et al., 2000). Also driven by the paucity of behavioral research, Paunonen and colleagues (Paunonen, 2003) predicted various behavioral categories on the Behavioral Report Form (Paunonen & Ashton, 2001) from extraversion as measured by the NEO-PI-R, the NEO-FFI, and the FF-NPQ (Paunonen & Ashton, 2002). Across scales, extraversion reliably predicted alcohol consumption, popularity, parties attended, dating variety, and exercise (Paunonen, 2003) .

One limitation of research on specific behavior described thus far are that the behaviors were not collected in actual environments. An exciting new methodology called Big EAR (Mehl & Pennebaker, 2003), circumvents this problem. Big Ear is simply a small recording device that is programmed to turn on and off throughout the day, recording for a few minutes at a time, producing objective data in natural environments. In a study using Big EAR to investigate behavioral correlates of extraverts as well as judges' folk theories of Extraverted behavior, it was found that extraversion, as measured by the BFI (John & Srivastava, 1999), related to talking and spending time with people; additionally, judges rated people who were more talkative and social as more extraverted (Mehl, Gosling, & Pennebaker, 2006).

Although there has been some research on how personality predicts actual behavior, there has been almost no research on how personality affects dynamic patterns of behavior in different situations. However, Eaton and Funder (2003) were able to conduct a study that revealed how extraversion influences dynamic social interactions. As in other studies, it was found that extraverts behaved more socially than introverts; it was also found that extraverts influence the behavior, affect, and interpersonal judgments of those with who they interacted, generally creating a more positive social environment. The question of why extraverts are so adept socially is unresolved at this time, but one intriguing possibility is that extraverts have certain abilities that are lacking in introverts. Support for this notion comes from a study that measured extraversion with the EPI and found that extraverts are better at non-verbal decoding than introverts when it is a secondary task (Lieberman & Rosenthal, 2001), as may be the case in social situations .

How do extraverts think?

Individual differences in behavior can be assessed in various categories as described above; in contrast, individual differences in cognition are reflected in the different ways that people categorize the world. Extraversion has been found to predict differences in

categorization across various tasks. Broadly speaking, extraversion relates to a relatively positive view of the world, as extraverts judge neutral events more positively than introverts (Uziel, 2006). Extraversion predicts categorization of words by their positive affective quality rather than their semantic quality (Weiler, 1992). For example, extraverts are more likely to judge the words “hug” and “smile” as more similar than the words “smile” and “face”. Extraversion also predicts judging positive valence words, e.g., “truth” and “honesty” as more similar than negative valence words, e.g., “grief” and “death”, although extraverts are not faster to categorize positive words by valence faster than negative words (Rogers & Revelle, 1998). This finding suggests a categorization advantage for positive valence only when processes are competing. Extraversion also does not relate to classifying rewards faster than threats; however, among people scoring low on IPIP extraversion, quickness to classify threatening stimuli related to experiencing negative affect in daily life (Robinson, Meier, & Vargas, 2005). In this study, quickness to classify threatening stimuli did not relate to negative affect among individuals scoring high in extraversion, suggesting that extraversion might be a protective factor against sensitivity to threat.

One concern that might be raised is that concurrent mood is responsible for the cognitive differences described above. An example of how mood effects cognition is given by a study finding that state positive affect predicts classification of objects by their broad, global features over their local features (Gasper & Clore, 2002). Studies examining the combined effects of extraversion and positive affect are in their beginning stages, and as such results are quite complicated at this point. Although extraversion (measured with the EPQ) had a positive main effect on choosing positive valence homophones over neutral homophones, completing open-ended stories with more positive tone, and recalling more positive than neutral or negative words in a free recall task, this effect was positively moderated by current positive affect when positive affect was experimentally induced, but not when mood was allowed to vary freely (Rusting, 1999). A different study found that an extraversion composite consisting of the EPQ, BAS/BIS scales, and the Generalized Reward and Punishment Expectancy Scales “GRAPES” (Ball & Zuckerman, 1990) related to beliefs that positive events are more likely in the future (Zelenski & Larsen, 2002); however, in this study extraversion did not interact with naturally occurring or experimentally manipulated positive mood, but a unique main effect of positive affect emerged when mood was experimentally manipulated. Future research will need to employ clever methods in order to clarify the complex relationships of extraversion and positive affect to cognition.

What do extraverts want?

Comparatively little work has examined motives and goals that are associated with extraversion. Initial investigation into this area revealed that extraversion is generally associated with high motivation for social contact, power, and status (Olson & Weber, 2004), personal strivings (Emmons, 1986) for intimacy and interdependence (King, 1995), and wishing for higher positive affect and interpersonal contact (King & Broyles, 1997).

It was recently suggested that the correct level of abstraction for investigating the

relationship between desire and a broad, higher order trait such as extraversion and is probably not at the relatively narrow level of concepts such as personal strivings and wishes, but rather at the broad level of major life goals (Roberts & Robins, 2000). At this level, NEO-FFI extraversion related to having more economic (e.g., status and accomplishment), political (e.g., influencing and leading), and hedonistic (e.g., fun and excitement) goals (Roberts & Robins, 2000). These findings were subsequently replicated in another study finding that NEO-FFI extraversion was related to social goals (Roberts & Robins, 2004). This study also determined that positive increases in extraversion in early adulthood were related to assigning increased importance to economic, aesthetic, social, economic, political, and hedonistic goals. These initial findings suggest that motivation, especially at the level of broad life goals, is an area ripe for important discoveries that is largely untapped at this point.

Extraversion and Psychopathology

In general, the importance of studying the relationships between normal personality and psychopathology rests on the possibility that personality factors could indicate early and persistent risk for the development of psychopathology (Krueger, Caspi, Moffitt, Silva, & McGee, 1996; Markon, Krueger, & Watson, 2005). Recently renewed interest in the relationships between normal personality and abnormal personality have led to investigations of how extraversion relates to various forms of psychopathology (Widiger, 2005).

As a general dimension of personality, extraversion most obviously has implications for personality disorders; a personality disorder is defined by the DSM-IV-R as “an enduring pattern of inner experience and behavior” that is “stable and of long duration, and its onset can be traced back at least to adolescence or early adulthood” (APA, 2000, p 689). In general, low extraversion is negatively correlated with the presence of personality disorders, but this finding is not universal, as there are some studies implicating high extraversion in certain personality disorders (Widiger, 2005); see Costa and Widiger (2002) for a diverse set of reviews. That both high and low extraversion relate to personality disorders is reminiscent of Nettle’s suggestion that both poles of normal personality dimensions involve costs and benefits (Nettle, 2006).

Although Hans Eysenck had examined the importance of extraversion in psychiatric diagnoses (H. J. Eysenck & Himmelweit, 1947) and continued to emphasize the application of normal personality traits to psychopathology (H. J. Eysenck, 1957), recent investigations of the relationships between normal personality and psychopathology outside of the personality disorders began in earnest with the groundbreaking study of Trull and Sher (1994). They measured normal personality with the NEO-FFI and showed that low extraversion, unique from the other FFM dimensions, predicted depression and anxiety. Krueger et al. (1996) added to the knowledge of the relationships between normal and abnormal personality by conducting a large study examining how MPQ (Tellegen, 1982) dimensions related to psychological disorders. In regards to extraversion, the Social Closeness scale was nega-

tively related to conduct disorder, affective disorders, and substance use disorders, whereas the Social Potency scale was positively related to conduct disorder and substance abuse disorders. More recent research has looked specifically at extraversion's role in anxiety and depressive disorders, with one study finding EPI extraversion to be negatively related to anxiety and major depressive disorder, but that extraversion's relationship to anxiety did not remain when statistically controlling for gender, age, and education (Jylha & Isometsa, 2006).

Extraversion and the Future

It is an exciting time to be investigating extraversion, as significant advances are accruing at a fast rate in various content areas, spurred on by the use of a wide range of the cutting edge research methods. We are optimistic that the coming research on extraversion will prove even more innovative and impactful and offer three areas that promise to be particularly fruitful. First, research should investigate how extraversion is implicated in ongoing functioning. We echo Funder's calling for more behavioral studies employing both self and other reports (Funder, 2001), as well as the continued development of unobtrusive methods such as Big EAR (Mehl & Pennebaker, 2003). Particularly interesting will be studies investigating social processes in terms of the dynamic state manifestations of behavior, feelings, thoughts, and desires.

A second area of investigation that we believe shows great promise are tests of the new RST (Gray & McNaughton, 2000). We believe that RST could become the unifying theory for extraversion research, as it has implications for studies at every level of personality research from genetics and brain structure to patterns of thoughts and behavior. We encourage future investigations to integrate research between different levels in the attempt to elucidate mediating pathways; for example, it may be possible to find genetic markers of brain structures that implicated in the BIS, BAS, and FFFS (Corr, 2008; Smillie, in press). The third area we highlight is the growing ease of public domain personality assessment, specifically using the IPIP item pool (Goldberg et al., 2006). The ability to obtain a large quantity of data in a relatively short period of time (Goldberg et al., 2006) makes public domain assessment the method of choice for investigating the following questions. What extraversion scales and items have the best predictive validity for various domains such as health, occupational success, and interpersonal functioning? What are the lower order facets or aspects that extraversion encompasses? How does extraversion content fit into higher order factors of personality? The first data using public domain assessment to address these questions has recently been reported (DeYoung et al., 2007; Grucza & Goldberg, 2007; Revelle, Wilt, & Rosenthal, in press).

Conclusion

Greek philosophers intuited that one fundamental ways that people differed was their propensity to act bold, talkative, and assertive. Twenty-five hundred years later, psychol-

ogists armed with advanced psychometric techniques are building a scientific paradigm around the construct in which the Greeks were interested. Rooted in one's genes, brain structure and function, and early temperament is the personality trait of extraversion. Similar to any other personality trait, extraversion is expressed in individual differences in a person's characteristic patterns of feelings, actions, thoughts, and goals. We are encouraged by the recent progress and growing interest in extraversion, and we are confident that as personality theory and research methods continue to become more accurate and precise, an even greater array of extraversion's implications across a wide variety of social, occupational, and clinical contexts will be revealed.

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