Extraversion

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Introduction

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-Introversion[1] 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; H. J. Eysenck, 1970, 1973; Goldberg, 1990; Norman, 1963). As such, Extraversion has the potential to explain the covariation of a wide variety of behaviors, which is 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 (Bagby, Costa, Widiger, Ryder, & Marshall, 2005) and also resilience (Jylha & Isometsa, 2006) for dif-

ferent forms of psychopathology.

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.

At the most basic, psychology in general, and personality theory in particular, is concerned with what people do. To explain these behavioral acts, theorists since Plato have made use of three latent constructs that have universal appeal: affect, cognition, and desires (see e.g., Hilgard (1980); Mayer (2001); Scherer (1995)). Subjectively this approach makes good sense, for we all recognize the effect upon our behavior of differences in our feelings, differences in our thoughts, and differences in our goals. MacLean's well known organization of gross brain structures into evolutionarily derived motor, affective, and cognitive components (MacLean & Kral, 1973; MacLean, 1990) has provided the twentieth century with mechanistic descriptions for Plato's (cognitive) charioteer driving his horses of feelings and aspirations.

We borrow our thinking from analyses that emphasize emotions as the integration of affective feeling states, cognitive appraisals, and behavioral activation (Scherer, 1995). Invoking an analysis of the

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[1] Although 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.

three levels of processing (reactive, routine, and reflective) discussed by Ortony et al. (2005) we believe that just as a full fledged emotion can be seen as the integration of the ABCDs across all three levels, so can personality. We reason analogically that as climate is to weather, so is personality to emotion ("personality is what you expect, emotion is what you get").

To us, it is necessary to analyze personality traits in terms of the behavior exhibited in a particular situation as accounted for by the situational demands, the affective reactions (both positive and negative), the cognitive framing of the situation, and the relationship of the possible sets of behaviors to long range goals and desires. This is more useful than examining any one of these components by itself. Observing someone running is not useful unless we know whether the person is running towards a loved one or an enemy or away from a threat. Similarly, knowing that people are deathly afraid of heights does not necessarily predict they will avoid a shaky suspension bridge if they have a strong enough need to get across a chasm.

Although analyzing personality measures in terms of the ABCDs has been done before (Johnson, 1997; Pytlik Zillig, Hemenover, & Dienstbier, 2002), we find this a particularly useful framework for considering Extraversion. As we will show, some of the confusion of measurement of this trait represents disagreements about the relative importance of the affective, behavioral, cognitive, and motivational bases of the trait.

The remainder of the chapter is organized as follows. First, we present a brief history of the interest in Extraversion. Second, the main focus of the chapter is devoted to current trends in research on Extraversion. Third, 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.

Theophrastus was a student of Aristotle and was most famous as a botanical taxonomist. However, he is known to most psychologists as a personality taxonomist who organized the individual differences he observed into a descriptive taxonomy of "characters" (Theophrastus, Jebb, & Sandys, 1909). 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 that looks remarkably similar to equivalent tables of the late 20th century (John, 1990; John & Srivastava, 1999). Although many credit Lew Goldberg, Warren Norman, or John Digman for establishing the importance of the "Big 5", perhaps we should give more credit to Theophrastus (Table 1). 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 noteworty personality taxonomy was the model of the four temperaments described by Hippocrates and Galen and reorganized into two dimensions (changeability and excitabiliity) by Wundt (Wundt & Judd, 1897). The choleric and sanguine temperaments can be characterized as being more changeable whereas the melancholic and phlegmatic temperaments were 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.

Although people were recognized as falling at a certain level on a behavioral dimension as far back as 2500 years ago, it was not until Immanuel Kant popularized the notion of type that it became ac-

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

ceptable for scientific study (Stelmack & Stalikas, 1991). Wilhelm Wundt was a main beneficiary of the focus on types as he was the first to notice the a dimension similar to Extraversion in the four temperaments of antiquity.

The names Extraversion and Introversion were brought into the popular terminology of psychology by C.G. Jung (Jung, 1921/1971). In Jung's conceptualization, 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 for the Extraversion dimension, the less known but very important work of Gerard Heymans (H. J. Eysenck, 1992) had already identified an Extraversion dimension similar to Jung's along a continuum of "strong" and "weak" functioning. It is also Heymanns whom we should credit for the development of psychometric methods, experimental approaches to personality, and situating psychological research in the hypothetico-deductive method, advances that no doubt have influenced contemporary research and theory on Extraversion (H. J. Eysenck, 1992).

Mid twentieth century taxonomies

The descriptive tradition in personality, as mentioned before, has its roots in Theophrastus and Galen. In the twentieth century, psychologists began serious efforts to describe the major dimensions of personality, and all such efforts have identified Extraversion as a major dimension. In a series of experimental and taxometric studies in the late 1940s and early 1950s, Hans Eysenck demonstrated the importance of Extraversion as a fundamental dimension of personality (H. J. Eysenck & Himmelweit, 1947; H. J. Eysenck, 1952). Not only did he try to explain Extraversion in terms of basic principles of learning theory, he was also one of the first to try to describe the core features of the trait. and developed scales to assess personality, the Maudsley Personality Questionnarire, 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 per-

sonality, 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 and also the approach behavior content emphasized by Gray (1981). 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

Sir Francis Galton introduced the "lexical hypothesis" that every descriptive term for behavior can be found in the language. He proposed that we could measure "the number of the more conspicuous aspects of the character by counting in an appropriate dictionary the words used to express them" (Galton, 1884, p 181). Raymond Cattell laid the foundation for modern lexical analysis when he factor analyzed 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 5. Following the lead of Fiske (1949) and Tupes and Christal (1961) on peer ratings, and his own work on peer ratings based on paragraph descriptors (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, Consci-

entiousness, 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) also identifies Extraversion as a primary factor. Although often used synonymously with the Big 5, there are at least three major distinctions. First, the FFM was derived from factor analysis of questionnaires rather than adjectives. The original intent was to add an Openness dimension to questionnaires measuring the Giant Two emphasized by Eysenck. Second, genetic causes are assumed to underlie the FFM, whereas the Big 5 is purely a descriptive model. Third, 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 (Tellegen et al., 1988).

Socioanalytic Theory. Another personality theory with seven factors in which Extraversion ap-

pears 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 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, 2007; Lee & Ashton, 2004), which adds honesty to the Big 5 factors (Ashton & Lee, 2005) and has been replicated across various cultures. The core feature of Extraversion is thought to *active engagement in social endeavor*, which is assumed to be one of the common tasks for humans in evolutionary history (Ashton, Lee, & Paunonen, 2002).

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.

Further studies have found evidence that *agentic and affiliative* Extraversion are different constructs. Agentic Extraversion (but not affiliative Extraversion) predicts positive activation responses to incentive stimuli presented as pictures and in films, and affiliative Extraversion (but not agentic Extraversion) predicts warmth and affection to affiliative stimuli (Morrone-Strupinsky & Depue, 2004; Morrone-Strupinsky & Lane, 2007). In these studies, agentic Extraversion was measured with the MPQ (Tellegen, 1982) social potency scale and affiliative Extraversion was measured with the MPQ social closeness scale.

Summary: Taxonomies

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.

The measurement of Extraversion

Commonly used scales

Although there are not as many inventories 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), 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).

Recent and current theories

It is obvious that contemporary researchers investigating Extraversion owe much to early personality theorists. Over the past 60 years, the development of biological and statistical methods has allowed research on Extraversion to expand far beyond its beginnings.

Eysenck and Conditioning

It is appropriate here to review the work of Hans Eysenck as he 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

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 Questionnare	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

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.

Eysenck and Arousal

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 the ascending reticular activating system (ARAS) than extraverts. The ARAS is a feedback loop connecting the cortex to the reticular activating system. The link between the conditioning and arousal models is that the ARAS was also specified by Eysenck as the physiological correlate of conditioning and learning because it was known that the ARAS influenced excitatory and inhibitory processes in muscles.

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 to 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.

Gray and Reinforcement Sensitivity Theory

Over the last 50 years, Eysenck's hypotheses have generated thousands of studies yielding vary-

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

ing degrees of support (Matthews & Gilliland, 1999). More interesting and 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), which was thought to have origins in the mesocorticolimbic dopaminergic system; b) the Behavioral Inhibition System (BIS), thought to be mediated by the septo-hippocampal system; and c) the Fight-Flight System (FFS), thought to be mediated primarily by the hypothalamus and amygdala. The BAS was thought to be responsive to conditioned appetitive and non-punisment stimuli, the BIS to conditioned aversive stimuli, and the FFS to unconditioned aversive stimuli. Additionally, 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. Specifically, Impulsivity was graphically rotated 45 degrees in conceptual space from Extraversion (although the correct angle is thought to be 30 degrees (Pickering, Corr, & Gray, 1999)) and anxiety 45 degrees from Neuroticism; 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 this 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). Both theories made predictions about performance; however, the Matthews and Gilliland (1999) review concluded that relying on biological factors to predict performance might not be a useful tactic in human research; instead, it was suggested that postulating more proximal cognitive determinants of performance might generate more testable hypotheses. Thus, performance could be better modeled not only based on sensitivities of the BIS and BAS, and the arousal of the ARAS, but could be seen as a function of a dynamic system involving expectancies, desires, and feelings that are rooted in prior behavioral experience (Revelle, 1993).

Since the time of the Matthews and Gilliland (1999) review, Eysenck's theory continues to be tested in creative ways with new methods. For example, Blumenthal (2001) used a startle paradigm to determine that, because introverts are more easily aroused than extraverts, introverts are less distractible and more able to focus their attention in arousing situations. Beauducel, Brocke, and Leue (2006) found that a sudden decrease in workload level resulted in an immediate significant decrement in performance for extraverts but not introverts, which is consistent with the notion that extraverts need more stimulation than introverts to attain a level of arousal conducive to high performance.

Gray's theory not only continues to be tested, but

has undergone drastic revisions based on new findings from animal research (Gray & McNaughton, 2000; Smillie, Pickering, & Jackson, 2006). The main change to the theory is that the system formerly referred to as the FFS (now FFFS - "Fight, Flight, Freeze System") has been given a greater role, mediating responses to all aversive stimuli and generating the fear response. The BAS is still seen as mediating responses to appetitive stimuli, but the BIS is now seen as mediating conflict between the BAS and FFFS as well as conflict between appetitive responses. As such, the BIS is thought to mediate anxiety that occurs due to conflict between the other behavioral systems. Early tests of the new RST have shown that fear and anxiety can be separated (Cooper, Perkins, & Corr, 2007; Perkins, Kemp, & Corr, 2007), and a new book (Corr, 2008) examines exciting new approaches to testing RST.

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.

Current Directions

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. Contemporary 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, neuroanatomical and neurophysiological, 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

All explanations for Extraversion must be consistent with evolutionary theory (McAdams & Pals, 2006; Penke, Denissen, & Miller, 2007). It has been claimed that evolutionary theory must anchor personality theory, as Buss (1991, 1995) proposed that personality dimensions evolved to deal with domain specific tasks in the social environment, and

that the most noticeable personality dimensions reflect the most important aspects of the evolutionary social landscape. 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 by evolutionary theorists (e.g., Penke et al. (2007)). 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 that different levels of personality traits reflects 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). Penke et al. (2007) consider a number of ways that variation in personality traits can be maintained in addition to the balanced polymorphisms discussed by Nettle (2005) but does not specifically apply them to Extraversion.

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).

The dopaminergic hypothesis of agentic Extraversion

Genes do not act directly on behavior; genetic effects are mediated by brain structure and function (Revelle, 1995). Eysenck and Gray were the first to detail complex theories about how this might be the case for Extraversion. Recently, Depue developed a novel theory for agentic Extraversion[2] that 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) . The neuroanatomical correlate of the BFS is thought to be the mesocorticolimbic dopamine system, which originates in the ventral tegmentum and projects to the pre-frontal cortex. 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

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[2] The neurobiology of Depue's affiliative Extraversion has only recently received research attention, but is generally thought to be based on opiate functioning (Depue & Morrone-Strupinsky, 2005)

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. Also, D2 receptors are more susceptible to blockage by Remoproxide in introverts than extraverts, suggesting that Introversion predicts dopaminergic reactivity (Rammsayer, 1998). Recent studies have provided a more detailed picture of how dopaminergic functioning relates to Extraversion. In an fMRI study, Extraversion, as measured with the BFI (John & Srivastava, 1999), along with the presence of the TaqA1 allele on the D2 receptor gene (although neither by themselves) predicted greater activation magnitudes in the brain's reward system during reward, but not anticipation activations in a gambling task (Cohen, Young, Baek, Kessler, & Ranganath, 2005). 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).

Extraversion and Brain Structure/Function

It is clear 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. The general rationale for these studies is that one's level of Extraversion should relate to activation in brain areas involved in emotional processing when affectively

valenced stimuli are presented. In all studies, Extraversion was measured with the NEO-PI-R (Costa & McCrae, 1992b).

Hypotheses consistent with this rationale have received support across a range of tasks using fMRI methodology. In one study (Canli et al., 2001), extraverts passively viewed positive valence stimuli in an fMRI, and correlational analysis revealed strong associations, ($r = .80$), between Extraversion and activation in the amygdala, caudate, medio-frontal gyrus, and the putamen. Additionally, Extraversion was not related to differential activation to negative stimuli. Another study showed that perception of emotion differentially activated the amygdala depending on Extraversion (Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002). When participants were shown happy faces, amygdala activation was correlated above $r = .7$ with Extraversion; additionally, Extraversion was not related to amygdala activation for fearful, angry, or sad faces. A third study showed that positive valence words in the Emotional "Stroop" task activated the anterior cingulate cortex to a greater extent for more extraverted individuals (Canli, Amin, Haas, Omura, & Constable, 2004). Finally, in a visual search task, Extraversion predicted greater activation of the right fusiform gyrus when a positive probe was masked by a neutral probe (than when a neutral probe was masked by a positive probe), and when a neutral probe was masked by a negative probe (than when a negative probe was masked by a neutral probe); these results suggest that extraverts avoid attending to less positive stimuli.

One important implication of all 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. During an oddball task in which people must identify non-target trials, Extraversion measured with the EPQ (S. B. Eysenck & Eysenck, 1975) predicted activation in the lateral pre-frontal cortex, lateral parietal cortex, and right anterior cingulate cortex during discrepancy trials; 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) sought to determine whether different NEO-PI-R facets of Extraversion

accounted for the association noted above between Extraversion and anterior cingulate cortex activity (Canli, 2004; Eisenberger et al., 2005). They found that the facets of excitement seeking and warmth served as mediators when viewing positive valence words.Two other novel findings from this paper were that Extraversion predicted functional connectivity to the anterior cingulate while viewing positive words, 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.

In addition to differences in function, differences in brain structures are associated with level of Extraversion, and such differences may have diverse implications for psychopathology, learning, and behavior. MRI studies have shown that NEO-PI-R Extraversion is correlated with gray matter in the left amygdala (Omura, Constable, & Canli, 2005); this may suggest that Extraversion is a protective factor against depression because reductions in amygdalar gray matter predict depression (Omura et al., 2005). Extraversion (as measured by the NEO-FFI) and thickness of orbitofrontal cortex and are associated; moreover, extinction of fear retention mediates the path from orbitofrontal thickness to Extraversion (Rauch et al., 2005), suggesting one way in which brain structure influences learning processes, thereby also influencing personality. One way that brain structure relates to specific components of Extraversion 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, areas that have been suggested as possible substrates underlying impulsive and disinhibited behavior (Wright et al., 2006).

Finally, there are broad hemispheric associations with Extraversion. Herrington, Koven, Miller, and Heller (2006) reviewed evidence suggesting that left hemisphere lateralization is associated with approach behavior and positive affect; because NEO-FFI Extraversion loads on a higher order 'approach temperament' (Elliot & Thrash, 2002) factor

along with scales measuring positive affect (Watson, Clark, & Tellegen, 1988) and behavioral approach sensitivity (Carver & White, 1994), it is reasonable to hypothesize that this higher order 'approach temperament' factor might predict left lateralization. Although results have been mixed in predicting this association, 'approach temperament' has been found to predict high performance on a variety of neuropsychological tasks that require cognitive functions that are specialized to the left prefrontal lobe (Herrington et al., 2006).

Development

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 (Caspi, Roberts, & Shiner, 2005; Durbin, Klein, Hayden, Buckley, & Moerk, 2005; Rothbart, 1981). Temperament appears earlier than fully developed personality, and its dimensions are usually conceptualized as more narrow than personality dimensions (Rothbart, Ahadi, & Evans, 2000). The dimensions of temperament may be thought of as precursors of personality in a more simplified state; one illustrative comparison is that whereas personality dimensions include patterns of cognition, temperamental dimensions includes patterns of attentional sensitivities (Rothbart et al., 2000; Rothbart & Bates, 2006). A useful analogy for understanding temperament as it relates to personality is that, if a personality trait were a snowball, temperament would be its hard ice core (Graziano, Jensen-Campbell, & Sullivan-Logan, 1998). One way that temperament might develop into personality is through the expectations of significant caregivers in the social environment (Graziano et al., 1998).

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 et al., 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 negative 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. Relating these observations to temperament, it may be the case that Eysenck's theory and RST are more appropriate to test with younger children, given that their theories conceptualize mediators of performance at the level of temperamental variables arousal and attention rather than complex cognitive functions.

The regulatory capacities that are included in temperament have been proposed as the fundamental building blocks for traits (Gramzow et al., 2004). The fundamental dimensions of regulatory processes are ego control and ego resilience (Block & Haan, 1971; Block, 2002). People high on ego control inhibit their immediate motivations, whereas those low in ego control express these motivations quickly. Ego resilience refers to how able an individual is to control one's typical ego control response; as such, people high in ego resilience are able to refrain from expressing their immediate motivations in behavior even if they are low in ego control. Little research has looked at the direct links between regulatory tendencies and personality traits; however, Gramzow et al. (2004) did find that Extraversion (measured with the BFI) was related to lower levels of Ego control and higher levels of Ego resilience. These findings suggest that extraverts express their immediate motivations but are also able

to successfully subvert these tendencies when necessary. Ego control and ego resilience are similar to aspects of temperament such as adaptability and approach/withdrawal (Gramzow et al., 2004); thus, it may be that these temperamental components are especially relevant to the development of adult personality.

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; Lyubomirsky, King, & Diener, 2005), 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; Flory, Manuck, Matthews, & Muldoon, 2004; 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, it would be rash to conceptualize Extraversion and positive aspects as redundant construct for at least three reasons. First, as noted, they shared only 30% of the total variance between constructs (Watson, 2000). Second, behavioral content is better represented than positive affect in measures of Extraversion (Pytlik Zillig et al., 2002). Pytlik Zillig et al. (2002) examined widely used measures of Extraversion to determine what percentage of items dealt with affect, behavior, and cognition, and found that 53% of items were primarily behavioral, 38% were affective, and only a very low 9% were primarily concerned with cognitive aspects. 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. Ashton et al. (2002) constructed a social attention scale that measured a unitary construct of the propensity to behave in ways to attract social attention; representative items of this scale are "you are frequently the center of attention", and "you like to entertain others". They found that social attention correlated higher with Extraversion than positive affect as measured by the PANAS (Watson et al., 1988) or approach behavior as measured by the BAS scale (Carver & White, 1994). Additionally, the first factor in a factor analysis of Extraversion facets, the social attention scale, the BAS, and the PANAS was a factor that reflected primarily social attention content.

There are two additional problems with concluding that Extraversion and positive affect represent the same construct. First, although personality and affect are operationalized in much the same way, personality is at a different level of abstraction than affect (Yik & Russell, 2001). Personality is a stable, long-term dispositional variable, whereas affect is a momentary state. Second, even constructs at the same level of abstraction that are widely assumed to be parts of the same construct may be different. For example, happiness and sadness are not bipolar opposites, separated by 180 degrees as is commonly assumed; they are instead separated by 120 degrees and are not inversely related to experimental manip-

ulations (Rafaeli & Revelle, 2006).

Extraversion and PA 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 ac-

curacy 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).

Depue's biological model seems to offer reasons why findings have supported both the affect-level and affect-reactivity models (Depue, 1995; Depue & Collins, 1999). This model hypothesizes that extraverts have higher baseline dopamine activation, leading to higher tonic positive affect, and that extraverts' dopamine reactivity in the Behavioral Facilitation System (BFS) is higher than that of introverts, leading to greater reactivity to positive stimuli. Other neurophysiological findings described earlier can also be taken as supporting both the affect-level model and the affect-reactivity model. In support of the affect-level model, approach temperament predicts higher baseline levels of left frontal brain activity, (Herrington et al., 2006); in support of the affect-reactivity model, extraverts have higher activity in various areas of the brain implicated in reward under positive, but not neutral or negative valence conditions (Canli, 2004).

Structural explanations assume that the relationship between Extraversion and positive affect is fixed; that is, there are differences between extraverts and introverts that result in extraverts experiencing more happiness regardless of what they do. Tests for mediators of the Extraversion - positive affect relationship have focused on identifying fixed differences between extraverts and introverts. Fossum and Barrett (2000) found that the relationship between trait Extraversion and trait positive affect was mediated by positive self-evaluation. Lischetzke and Eid (2006) found that extraverts are happier than introverts because they are have better mood maintenance abilities, the ability to prolong positive moods and shorten negative moods. These findings both emphasize Lucas and Baird (2004)'s contention that the relationship between Extraversion and positive affect is multiply determined and

thus is likely to warrant multiple explanations.

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. Argyle and Lu (1990b) found that extraverts participate in more social activities than introverts, and that amount of social activity partially mediated the Extraversion - happiness relationship. In another study, Argyle and Lu (1990a) identified social competence as a mediator. However, there is also 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. However, a social situation was defined as involving at least one other person (Pavot et al., 1990). According to this categorization, two introverts quietly talking about a book are just as socially involved as ten extraverts at a raucous party. Lucas and Diener (2001) provide a reconciliation for the contradictory findings; extraverts enjoy social situations more than introverts only when the situations is pleasant, suggesting that the positive nature of the social situation, not the social nature itself, leads to extraverts' increased happiness relative to introverts. Regardless, sociability theory is not likely to provide a comprehensive explanation, as 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). State Extraversion is a new concept in the personality literature, and rests on the density distributions model of traits (Fleeson, 2001). The density distribution conceptualizes traits such as Extraversion as aggregates of behavioral states that have the same content as traits, but occur on a shorter time frame. For example, the content of state Extraversion includes being bold, adventurous, and talkative, whereas trait Extraversion is an individual's entire distribution of Extraversion states. Fleeson (2001) found support for this model across the Big Five dimensions, as within-person variability in Big Five states was found to exceed between-person variability. Recently, this finding was replicated outside the Fleeson lab (Heller, Komar, & Lee, 2007; Schutte, Malouff, Segrera, Wolf, & Rodgers, 2003). However, part of this effect is due to basic probability theory: the variability of single trials will exceed the variability of the means of multiple trials. That is, if Extraversion is seen as the probability, p, of being in a positive affect state and the probability, $q = 1-p$, of not being in a positive affect state, then the variance within a person will be pq while the variance of aggregated scores, aggregated over N trials will be pq/N. Even if people differ in their value of p, the distribution of single trials within subjects will exceed the variability between individuals on aggregated trials.

A within-person relationship means that state Extraversion predicts state positive affect. The general way to test for within-person relationships is to use Experience Sampling Methodlogy (ESM) (Conner, Barrett, Tugade, & Tennen, 2007) or Daily Diaries (Green, Rafaeli, Bolger, Shrout, & Reis, 2006). In ESM, individuals typically report a variety of ratings across different time-frame intervals, allowing researchers to examine the covariation among variables within each person as well as between-person correlations. A powerful statistical technique, mixed effects models (Pinheiro & Bates, 2000) also known as multi-level models or hierarchical linear modeling (Bryk & Raudenbush, 1992), has the ability to model both within-person and between-person relationships in the same equation. Fleeson et al. (2002) used ESM and multilevel modeling to find that all participants, regardless of trait level Extraversion, were happier when they acted extraverted. Also, in experiments where participants were instructed to act extraverted, they felt more positive affect, suggesting that state Ex-

traversion causes state positive affect (McNiel & Fleeson, 2006). Additionally, there is new evidence showing that state Extraversion mediates the relationship between approach goals and state positive affect (Heller et al., 2007).

Although no explanations for the state Extraversion - state positive affect relationship have been tested, Fleeson and his colleagues have suggested that explanations should include only factors that vary rapidly within persons (e.g., momentary dopaminergic activity) or in the environment (e.g., positive feedback) as opposed to fixed factors (trait reward sensitivity) (Fleeson et al., 2002). However, it may be possible for fixed factors to influence both the likelihood of both state Extraversion and state positive affect; as such, we recommend a dual approach looking at both dynamic and fixed factors when exploring the within-persons Extraversion - positive affect relationship. This approach has been implemented to examine whether the trait Extraversion - trait positive affect relationship can be explained by the covariation of Extraversion and positive affect states. That is, it was hypothesized that the reason that extraverts feel happier than introverts is because they enact more Extraversion states, and by doing so they achieve more positive affect states which leads extraverts to report higher levels of positive affect in general. This explanation has received some preliminary support (Wilt, Noftle, & Fleeson, in preparation), but requires much more research.

Most of the research looking at the direction of the relationship between Extraversion and positive affect has predicted positive affect from Extraversion (Yik & Russell, 2001).Wakefield (1989)'s hierarchical model of personality assumes that the direction flows from Extraversion to positive affect. In Wakefield's hierarchy, going from broad to narrow personality constructs, are: physiological characteristics with an evolutionary basis; primary, stable traits such as Extraversion; secondary traits such as positive and negative affect, which are less stable than primary traits and influence states; mood states, such as positive affect; and finally, intentional behavioral states. A partial test of this model was carried out by Nemanick and Munz (1997), who showed that the relationship between trait Extraversion, measured by the EPQ-R (S. B. Eysenck et al., 1985), and state positive affect, measured by a state form of the PANAS, was mediated by trait positive affect whether assessed by the PANAS or by

the MPQ (Tellegen, 1982). Similar to Wakefield (1989)'s model, it has been suggested that traits such as Extraversion and Neuroticism influence affect either directly, through differences in emotional sensitivity, or indirectly, through predisposition to certain actions that lead to affect (McCrae & Costa, 1991). In either case, this model assumes that Extraversion causes positive affect.

A somewhat different model for the relationship between personality and affect was proposed by Izard (Izard, Libero, Putnam, & Haynes, 1993). In this model, similar to previous models, traits are posited to influence emotions once traits are fully developed. However, Izard's model also allows affect the power to influence trait development, suggesting a bi-directional relationship between Extraversion and positive affect (Izard et al., 1993). Wilson and Gullone (1999) reasoned that if there were bi-directional effects, the correlation between Extraversion and positive affect would increase with age, whereas if the direction of influence went only from personality to affect, the correlation would remain stable. The results from a cross-sectional study found support for bi-directionality, as the correlation between Extraversion and positive affect increased with age; however, we agree with the authors that interpreting these results as indicating causal influence is speculative at best.

When causal direction is the issue, the value of the experimentally induced state approach to personality is revealed (Revelle, 2007). This is illustrated in the previously described experiments showing that state Extraversion caused state positive affect (McNiel & Fleeson, 2006). Future experiments should manipulate state positive affect to determine whether state Extraversion increases as a result. The question of whether trait Extraversion and trait positive affect are causal in their relationship to one another is more difficult, as the nature of traits makes them very difficult if not impossible to manipulate.

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 offers Extraversion as an example of a trait that has not been investigated in relationship to actual behavior. However, this seems

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 this important hole, 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 et al., 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, Panonen 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). The FF-NPQ deserves some mention as a behavioral measure itself, as it contains pictures of behaviors relevant to the Five Factor Model dimensions and asks how likely it is that one would engage in behavior of that sort. However, it does not count as a true behavioral criterion measure because the behavioral items are operationalizations of the FFM dimensions, not predicted from alternate measures of each trait. 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. Another advantage of Big EAR over traditional ESM is that it is unobtrusive; whereas ESM typically relies on interruptions at random or fixed intervals at which point the target reports behavior, Big EAR simply turns on and off surreptitiously. 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. Eaton and Funder (2003) blame the dearth of research like this on the person-situation debate as well as the logistical difficulties associated with such studies. However, they 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. Trait Extraversion in this study was measured using a Q-Sort technique (Block, 1961; McCrae, Costa, & Busch, 1986) and behavior was measured with the RBQ. 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 (H. J. Eysenck & Eysenck, 1968) and found that extraverts are better at non-verbal decoding than introverts when it is a secondary task (Lieberman & Rosenthal, 2001); this is likely to be the case in social situations and may free up resources for extraverts that introverts must keep engaged in the task of non-verbal decoding.

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 in a choice reaction time paradigm and go-no-go task 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 as this point. Although Extraversion (measured with the EPQ) had a positive main effect on choosing positive valence homo-

phones 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. Recently, studies similar to those conducted by Rusting (1999) and Zelenski and Larsen (2002), were carried out with results replicating the Extraversion (measured with the EPQ-R) main effect on homophone preference, story completion, and positive expectancies (but not free recall); interestingly, no interactions with positive mood were observed (Rafienia, Azadfallah, Fathi-Ashtiani, & Rasoulzadeh-Tabatabaiei, 2008). 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 the 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 hedo-

nistic (e.g., fun and excitement) goals (Roberts & Robins, 2000). These findings were subsequencly 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). Indeed, a large body of research suggests that personality disorders can be understood as maladaptive variants of the normal FFM personality dimensions, which in addition to Extraversion, include Agreeableness, Conscientiousness, Neuroticism, and Openness (Costa & McCrae, 1992a). The nuances of Extraversion's relationships to each specific personality disorder is beyond the scope of this paper; see Costa and Widiger (2002) for a diverse set of reviews. 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). 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 a personality profile of low Extraversion, Agreeableness, and Conscientiousness along with high Neuroticism and Openness was characteristic of substance use disorders, anxiety disorders, and mood disorders. It was also found 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 negatively 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. One study found that EPI Extraversion is negatively related to anxiety and major depressive disorder, but Extraversion's relationship to anxiety did not remain when accounting for gender, age, and education (Jylha & Isometsa, 2006). Another study found a positive relationship between Extraversion and amygdalar gray matter, possibly a protective factor against depression (Omura et al., 2005). This finding highlights that one general approach useful for studying the relationships between personality and psychopathology is to focus on identifying biological and genetic factors common to both normal and abnormal psychological characteristics (Canli, 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 processeses in terms of the dynamic state manifestations of behavior, feelings, thoughts, and desires. Extraversion state manifestations deserve continued attention, especially because they are amenable to experimental design and because of their robust and possibly causal relationship to positive affect states (Fleeson et al., 2002; McNiel & Fleeson, 2006). This association suggests that further investigation of Extraversion states could provide answers to the important questions of why trait Extraversion and trait positive affect covary (Costa & McCrae, 1980; Watson & Clark, 1997; Lucas & Baird, 2004). More generally, research focusing on ongoing personality functioning is well-suited to answering quetions about variability and flexibility that have just begun to be answered with empirical data (Baird, Le, & Lucas, 2006).

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 strucutres that implicated in the BIS, BAS, and FFFS. Additionally, two general challenges for research on RST will be to measure the three behavioral systems without relying on self-report (Corr, 2008) and to determine whether the redefined roles of the BIS and FFFS are useful in the prediction of human behavior.

The third area we highlight is the growing ease of public domain personality assessment, specif-

ically 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 in articles by Grucza and Goldberg (2007) and DeYoung et al. (2007).

Conclusion

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