

Cultural Neuroscience Insights to Individual Differences and Personality

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To appear as:

Rule, N. O., Mar, R., & Bjornsdottir, R. T. (in press). Cultural neuroscience insights to individual differences and personality (pp. XX–XX). In A. T. Church (Ed.), *Personality Across Cultures*, Vol. 3. Santa Barbara, CA: Praeger.

## Cultural Neuroscience Insights to Individual Differences and Personality

The biological sciences emerged to facilitate understanding of how organisms function, with disciplines like genetics and neuroscience providing useful windows into how genes and brains work. Both involve a wealth of innovative methodological tools. Neuroscience methods, for example, include studying patients who have suffered neurological insults, the behavior of single neurons, lesions to brain regions in non-mammalian species, and measures of brain activity through various forms of neuroimaging. Researchers outside of biology eventually appropriated these tools to study more complex and distinctly human processes.

For instance, studying the brain led scholars to wonder whether these same methods could be employed to study the mind. Tying cognitive functions to the brain and its workings became known as cognitive neuroscience, a discipline that experienced a meteoric rise in popularity during the 1990s. Since then, researchers have become increasingly bold, applying genetic and neuroscientific techniques to answer questions about progressively more complex forms of cognition and behavior, such as how culture shapes cognition and the underlying processes that support stable traits.

Adopting and adapting biological approaches to address new kinds of questions necessarily entails the acceptance of a greater number of risks to both validity and reliability. Yet doing so also provides a unique toolset for addressing these topics not possible through other means. Provided that researchers remain mindful of the difficulties that come with adopting these techniques, they can bear very promising fruit. In this chapter, we endeavor to review the unique concerns that accompany the application of genetic and neuroscientific methods to studying culture and personality.

### **What are Cultural and Personality Neuroscience?**

Cultural neuroscience explores the brain's role in explaining cultural differences for various psychological processes. It arose during the early 2000s, when the successes of cognitive neuroscience encouraged researchers interested in culture to explore whether these methods could inform their own research. Today, cultural neuroscience incorporates a variety of research topics, ranging from the influence of culture on basic processes such as sensation and perception to the role of culture in shaping more complex cognitive processes, such as person perception and theory-of-mind. Understanding cultural differences is central to its mission, and the tools of cognitive neuroscience provide a unique opportunity to deconstruct their underlying architecture. This nascent approach has already yielded many successes, often uncovering evidence of cultural variation where behavioral paradigms alone could not.

To fully appreciate cultural neuroscience, one must understand its parent fields. Cultural psychology arose from the incorporation of theories and methods from several fields within the social sciences: anthropology, linguistics, and social psychology. Although cultural psychology research had been conducted for much of the 20<sup>th</sup> century, it only emerged as a research interest in mainstream social psychology once Markus and Kitayama (1991) introduced questions about cultural differences to social cognition. This spurred dozens of investigations that now constitute the body of knowledge underlying the literature on cultural differences in social information processing (see Miller & Schaberg, 2003). Their review also represents a significant precursor to the birth of cultural neuroscience, as the attention to cultural differences among scholars of social cognition provided the bridge to cognitive psychology and, in turn, cognitive neuroscience. Specifically, the adoption of methods and theory from cognition among social psychologists in

the mid-20<sup>th</sup> century may have served as a critical step towards introducing cultural psychology to cognitive neuroscience.

Meanwhile, at roughly the same time as cultural psychology garnered the attention of researchers in social cognition, cognitive neuroscience began to blossom on its own. Though a thriving and independent field for decades prior, advances in functional magnetic resonance imaging (fMRI) technology in the early 1990s catalyzed a revolution in cognitive neuroscience research (Kwong, 2012). The adaptation of MRI to track blood flow in the brain gave researchers a new way to study its functions without the health risks and logistical obstacles presented by other imaging approaches (e.g., positron emission tomography) while simultaneously permitting greater spatial resolution than other extant technologies (e.g., electroencephalography [EEG]). Researchers and research institutes thus began to embrace this new technology (Belliveau et al., 1991; Jaffe, 2011). Since then, the number of brain imaging studies has skyrocketed as more institutions acquire their own research-dedicated MRI facilities and this wide adoption of brain imaging led to a broader range of research topics. Cognitive neuroscience, for example, expanded the purview of neuroscientific investigation from the brain to the mind (see Uttal, 2011, for an overview of the field's contributions). From the study of mental processes, it was only a short and obvious jump to social cognitive processes, affective neuroscience, neuroeconomics, and cultural and personality neuroscience.

Cultural neuroscience thus employs a wealth of behavioral and neuroscientific methods to investigate how culture influences the brain, and how the brain reciprocally contributes to building and maintaining culture (Kitayama & Tompson, 2010). As a result, it permits a broader exploration of both culture and neuroscience (B. W. Ng, Morris, & Oishi, 2013). Like both cognitive neuroscience and cultural psychology, it is an interdisciplinary field—both by

definition and in practice. As a result, it includes the investigation of diverse topics, from cultural differences in basic cognition (e.g., Hsu, Jacobs, Citron, & Conrad, 2015) to high-level social phenomena (e.g., Rule, Freeman, Moran, Gabrieli, & Ambady, 2010). Cultural psychologists have also begun to adopt a wider range of tools to help uncover the biological substrates of cultural influences. For instance, recent developments in social and cultural neuroscience have begun to include genotyping to better understand how genes shape brain development and, ultimately, human behavior (e.g., Chiao, 2011; Way & Lieberman, 2010). The real strength of cultural neuroscience is that it allows one to distinguish underlying properties of behaviors that, though they may appear isomorphic across cultures, result from different processes with unique neural signatures (e.g., Gutchess, Welsh, Boduroglu, & Park, 2006). Cultural neuroscience thus provides a unique means of uncovering differences in thought and behavior not detectable by other methods.

Personality neuroscience evolved in much the same way as cultural neuroscience, and the two may complement each other as well as overlap. Personality research began with the study of how people, and groups of people, differ from one another in their trait tendencies (McAdams, 1997). An interest in the biology behind these personality differences emerged during very early times, with Galen (A.D. 130–200) developing a model of temperament based on the four humors identified by Hippocrates (Stelmack & Stalikas, 1991). Moreover, the history of neuroscience has often touched upon questions related to personality. For example, perhaps the most famous brain injury patient, Phineas Gage (who suffered serious damage to his frontal lobes from a railroad accident), was in part a fascination due to the changes in his personality following his injury despite being relatively unchanged on other dimensions (Harlow, 1869). That said, within the modern history of personality psychology itself, research has traditionally focused on

systematically describing how people differ in the ways they tend to think, behave, and believe. A great deal of research toward this end eventually led to the formation of the Five Factor Model of personality, a description of five broad traits that encapsulate a great deal of the variability in how individuals differ. This model has proven widely successful in explaining a great number of individual differences, and is now widely accepted by researchers in this area (Costa & McCrae, 1992; John & Srivastava, 1999). In brief, people's stable tendencies to think and behave in certain ways map onto these five broad traits: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (often described via its inverse, Emotional Stability). Although some concerns regarding the "Big Five" model certainly remain to be ironed out (cf. Ashton, Lee, & de Vries, 2014; Block, 2010), its demonstrated utility has allowed the field to spread and explore a number of additional questions. For example, researchers have begun to successfully identify what more narrow traits exist below the Big Five (sometimes referred to as the 10 aspects), predicting more specific kinds of tendencies toward thought and behavior (DeYoung, Quilty, & Peterson, 2007; Soto & John, 2009). Additionally, although the Big Five traits describe distinct constructs, they also inter-relate in a systematic fashion to form two meta-traits known as Stability (Conscientiousness, Agreeableness, and Emotional Stability) and Plasticity (Openness and Extraversion; DeYoung, 2006; Digman, 1997). A wealth of research on these descriptive models of personality has demonstrated that these broad differences among individuals predict a great deal of daily behavior (Fleeson & Gallagher, 2009) as well as important life outcomes such as mortality and occupational attainment (Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007).

One criticism of personality research, however, is that its focus on description has neglected explanation. In other words, why do people develop these stable tendencies to think

and act in different ways? One way of better understanding the causes of stable tendencies in cognition and behavior is to explore the basic processes that support them, and the methodological tools of neuroscience and genetics provide an excellent fit for examining these processes. Basic brain-based functions will inevitably underlie any stable trait tendencies (DeYoung, 2015) and so neuroscientific investigations into brain areas, networks of brain areas, and neurotransmitters, will all help to explain how and why traits are expressed. Similarly, because genetics partly determine how the brain develops (Jahanshad et al., 2010), in conjunction with various environmental factors and their interaction, genotyping and similar tools will also help us to better understand the “why?” of personality. In this way, the biological tools of personality neuroscience afford us the best possibility of answering how personality emerges and why people differ in how they think and act (DeYoung & Gray, 2009)

### **Challenges that Limit Cultural and Personality Neuroscience**

Despite the impressive instruments and scientific gains that have blossomed from the marriage of neuroscience to cognition, traits, and behavior, the neuroscientific approach is not a panacea for unlocking the mysteries of the mind. Rather, personality and cultural neuroscience have pronounced challenges that limit their contributions and should be acknowledged at the outset. The tools of genetics and neuroscience were not originally designed to answer questions about complex human behavior but, instead, have been co-opted for this purpose. As a result, and unsurprisingly, increasingly difficult challenges arise when applying these methods to address intangible aspects of behavior (e.g., thoughts). Because these questions are of such interest and import, however, the challenges of bringing these new tools to bear seem well worth tackling.

Firstly, as afflicts cognitive neuroscience more broadly, the results of neuroimaging studies can be difficult to interpret. Simply observing activity in any one brain region does not imply that this particular swath of cortex is exclusively responsible for a specific function or behavior (Horwitz, 2003; Poldrack, 2011). In fact, individual brain regions are often associated with several different processes (Yarkoni, Poldrack, Van Essen, & Wager, 2011). Secondly, with no discredit to the profound innovations that have made cognitive neuroscience tractable, brain imaging suffers from notable technological restrictions. Most challenging to cultural neuroscience is the fact that subtle differences between specific MRI scanners can accumulate to produce substantial discrepancies in calibration, introducing confounds when comparing data across research sites. In this way, differences in results found between different cultures for measurements made *in situ* can result from measurement error, rather than true cultural differences (e.g., Glover et al., 2012). This problem mirrors some of the more familiar struggles of cross-cultural work, such as assuring proper translation and back-translation of one's measures across languages and cultures (Sperber, Devellis, & Boehlecke, 1994; van de Vijver & Leung, 1997; Weeks, Swerissen, & Belfrage, 2007). Additionally, because MRI scanners are expensive to purchase and operate, cultural neuroscience research tends to take place only at wealthy institutions within wealthy nations, which themselves tend to be fairly homogeneous across various dimensions and different from other populations in the world (Chiao & Cheon, 2010; Henrich, Heine, & Norenzayan, 2010). These technological restrictions thus amplify a problem already present within cultural psychology of disproportionately sampling people living in a small handful of nations. Many of the world's most diverse people (and therefore arguably the most interesting in terms of cultural insights) effectively lie outside of cultural neuroscience's reach, limiting the scope of this research.



Personality neuroscience faces similar challenges as cultural neuroscience for analogous reasons. One obvious issue affecting all of neuroimaging work is the difficulty of acquiring adequate sample sizes to obtain appropriate levels of statistical power. The expense of running neuroimaging studies (fMRI, in particular) can fiercely constrain sample sizes even in the wealthiest nations, challenging the reliability of the data acquired (Button et al., 2013). This can pose a particular problem for personality neuroscience, which often relies upon sufficient variability in trait tendencies to detect associations with other metrics. Small samples often suffer from range restriction with less data in the tails of a normal distribution (Mar, Spreng, & DeYoung, 2013). Even if one strives to sample the full distribution of a predictor variable, however, the increased sampling error of small samples can easily produce problematic outliers for the criterion variable. Small samples also mean low statistical power, creating numerous problems for interpreting results, inflated effect-size estimates, and increased risk of false negatives (exacerbated by the stringent alpha thresholds used to correct for multiple comparisons in neuroimaging; Yarkoni, 2009; Yarkoni & Braver, 2010). Even worse, small samples increase the likelihood of spurious results entering the research literature, despite thresholding corrections (Button et al., 2013; Green et al., 2008; Pashler & Harris, 2012).

Moreover, because personality neuroscience often employs correlations to examine how variability in one metric (e.g., response in a brain structure) covaries with another (e.g., proportion of participants' remuneration donated to a charity; Moll et al., 2006), additional sample size issues must be considered. One requires a larger sample to detect the same-sized effect when measuring correlations, relative to comparing means, when using null-hypothesis statistical testing (Mar et al., 2013). Moreover, correlations are quite vulnerable to outliers, only stabilizing at around 250 paired data points (Schönbrodt & Perugini, 2013). Considering the high

cost of scanning participants using MRI, sample sizes of 250 are impractical for most researchers and so one must be mindful of the very real pragmatic limitations on sample size when evaluating neuroimaging work. That said, the problems of small sample sizes cannot be ignored and should be acknowledged when present, even if they exist for practical reasons. In addition, researchers should strive for novel solutions to the issue of sample size, such as large-scale cross-institutional collaborations (Toga, Clark, Thompson, Shattuck, & Van Horn, 2012) and other methods of pooling neuroimaging data (Mar et al., 2013).

Furthermore, applying cultural neuroscience to questions of personality and individual differences presents some additional unique problems. Most notably, cultural differences that can be seen at a group level are not always discernible at the individual level. For example, Na et al. (2010) demonstrated that group-level differences in interdependence versus independence and analytic versus holistic cognitive style are not observable at the level of the individual. Thus, important group-level cultural differences may not possess parallel correlates at more specific levels of analysis, such as individual differences. Although this was only examined at the level of behavior, similar issues may exist for neuroscientific measures.

These limits notwithstanding, applying biological methods to better understand culture and personality presents unique opportunities for better understanding human behavior, provided that one considers the limitations and integrates the results with other approaches. In this chapter, we review a range of findings from cultural neuroscience, illustrating its contributions to understanding selected dimensions of culture, basic cognition, social processes, and personality.

### **Individualism and Collectivism**

Perhaps the most basic constructs used to differentiate cultures are those of individualism and collectivism. Whereas individualistic cultures emphasize autonomy, collectivistic cultures

value interdependence (Hofstede, 1980). These differences manifest not only in individuals' behavior and thought patterns, but also in their genes (Chiao, Cheon, Pornpattananangkul, Mrazek, & Blizinsky, 2013). For example, pathogens in an environment predict both cultural collectivism and selection for a specific variation of the serotonin transporter gene (Chiao & Blizinsky, 2010). Additionally, individuals in collectivistic cultures are more likely to have serotonin and opioid alleles associated with higher social sensitivity (Way & Lieberman, 2010). Cultural tightness and looseness (i.e., the sensitivity to social norms) also relates to genetic variations due to environmental influences (Chiao et al., 2013). Food deprivation and other ecological threats, for example, correlate with genetic selection of the short allele of the serotonin transporter gene, which in turn mediates the relationship between ecological threat and cultural tightness (Mrazek, Chiao, Blizinsky, Lun, & Gelfand, 2013). Basic cultural differences and genetic variations thus appear linked. These basic cultural differences also relate to differences in brain activity for various forms of cognition. Kitayama and Park (2010) proposed that cultural patterns of neural activity may stem from daily tasks that represent or uphold the basic values of a culture (i.e., independence or collectivism). In this way, culture maintenance could lead to cultural differences in neural activation, visible in a vast array of basic and complex cognitions.

### **Basic Cognition**

#### **Language**

Cultural differences in many respects begin with language. Linguistic boundaries often coincide with national boundaries and can separate and define cultural groups within nations, with linguistic variation unsurprisingly correlating with cultural variation (Romaine, 1994).

Naturally, there are exceptions: Americans, Australians, and Britons all speak English, but these

groups also possess distinct cultural elements. Language and culture also influence each other: cultural events and experiences can generate new turns of phrase, and language may constrain the terms available to express particular cultural concepts (Sapir, 1929; Whorf, 1940).

Culture also affects how the brain processes language. For instance, the brain responds differently to various orthographic systems. Whereas phonographic languages employ symbols representing the sounds that constitute speech (e.g., English), ideographic languages use symbols that historically began as pictures (e.g., Chinese; McArthur, 1998). This distinction can meaningfully impact how readers process written words. Specifically, the brain's visual word-form area tends to activate more in Chinese than Western readers due to the greater role of visual information required to read Chinese pictograms (Bolger, Perfetti, & Schneider, 2005).

Spoken language is also influenced by culture. For those who speak more than one language, various factors influence how these languages are processed, including age of second-language acquisition, extent of mastery, and general amount of language exposure (Perani & Abutalebi, 2005). For example, bilinguals who acquire their second language later in life show stronger activity in Broca's area and other language-related brain regions when making grammatical judgments about their second language versus their first (Wartenburger et al., 2003); bilinguals who learn both languages from birth do not show this difference. That said, some brain regions respond regardless of whether someone hears phrases in their native language or an unfamiliar tongue, suggesting that language processing may have some universal foundations (Pallier et al., 2003). Moreover, observable differences in the neural response to other aspects of language may emerge even among readers highly proficient in both languages. For example, reading a happy passage in one's native language results in greater activation of

emotion-processing brain areas compared to reading the same passage in one's second language, even for readers fluent in both (Hsu et al., 2015).

Language processing also differs individually. Each of us possesses a unique set of past experiences that can influence how we perceive and process things around us. One study examined the possibility that past experience with the events described in a story modulate how brain regions interact in response to hearing this story (Chow et al., 2015). Brain regions associated with specific modalities (e.g., visual processing) showed greater functional connectivity when processing story content relevant to that modality (e.g., highly descriptive passages) for individuals with more past experience with the events being presented. This illustrates how individual differences in life experience can inform language processing.

Individuals also differ in how they react to narrative texts, being naturally inclined to become more or less absorbed in a piece of fiction. We all know people who rapidly become involved in a narrative no matter how brief, and others who seem unmoved by even the most emotional pieces of fiction. Researchers have found a correlation between one's tendency to become engaged by fiction and the relative grey matter volume in the right dorsolateral prefrontal cortex (dlPFC; Banissy, Kanai, Walsh, & Rees, 2012). Similarly, a different group of researchers found greater cortical thickness in brain regions related to social processing (i.e., the left dlPFC and inferior frontal gyrus) and reduced thickness in other areas (the dorsomedial prefrontal cortex [dmPFC]) associated with the tendency to identify with fictional characters (Cheetham, Hänggi, & Jancke, 2014). These studies demonstrate the potential for rather complex variations in how brain structure relates to higher-level language processing between both individuals and cultural groups.

## **Visual Perception**

Behavioral studies have clearly established cultural differences in visual focus. People from Eastern cultures typically attend to the context in which objects appear in a scene, viewing them as an integrated whole, whereas Western perceivers tend to focus on the object while largely ignoring its context (Kitayama, Duffy, Kawamura, & Larsen, 2003). These differences in perception correspond to broader differences in individualism and collectivism. Although individualistic cultures conceive of specific individuals as entities, collectivistic cultures typically consider individuals and their contexts as linked, not unlike the shared relationships between objects and scenes.

Naturally, these differences manifest in neural activity as well. In one study, East Asian and American participants viewed images of objects and scenes while undergoing an fMRI scan (Gutchess et al., 2006). Consistent with the behavioral studies showing Westerners' greater focus on objects compared to scenes, American participants exhibited greater activation than East Asian participants in areas associated with object processing (i.e., the bilateral middle temporal gyrus, left superior parietal/angular gyrus, and right superior temporal/supramarginal gyrus). Another study evaluating the role of culture in visual perception measured European-American and East Asian participants' neural activity during a line judgment task (Hedden, Ketay, Aron, Markus, & Gabrieli, 2008). Based on Witkin and Goodenough's (1977) classic rod and frame task, the line judgment task requires participants to judge the absolute and relative lengths of lines contained within boxes that vary in size. Greater attention to context for East Asians relative to Westerners means that varying the size of the box containing the line should not perturb European-Americans' judgments, but should moderate the judgments of East Asians. Stated another way, we would expect judgments of the absolute length of the lines to be more accurate for European-Americans than for East Asians, but judgments of the relative length of

the lines (compared to the box) to be more accurate for East Asians. Indeed, East Asian participants showed greater activation in the dlPFC—an area implicated in cognitive control—when judging the absolute length of lines compared to judging the relative length of lines, suggesting greater difficulty with the absolute length judgments. Critically, however, individual differences in the East Asian participants' degree of acculturation to the United States (i.e., the extent of their identification with American culture) attenuated the difference in dlPFC activation. This demonstrates the dynamic influence of individual differences in cultural experience on both visual perception and its neural correlates.

### **Attention**

Culture also affects how attention guides sensory perception. Researchers in one study recorded neural firing from European-American and Asian-American participants (measured with EEG) as they tried to detect a particular target image from within a host of other (distractor) images (Kitayama & Murata, 2013). Although the two groups performed similarly, the European-American participants exhibited different patterns of neural activity compared to Asian-Americans. Specifically, the European-Americans had a larger N2 waveform (corresponding to early orienting of attention and the discrimination of targets) and a larger slow wave (a sign of deliberate attention and elaborate stimulus processing). Together, these differences suggest that European-Americans allocated more attention to the target object from the start of stimulus processing, relative to Asian-American participants. Furthermore, another study found that Asian-Americans had a greater N400 event-related potential (associated with perceptions of incongruence) when viewing objects with semantically incongruent (versus congruent) backgrounds, whereas European-Americans showed no differences (Goto, Ando,

Huang, Yee, & Lewis, 2010). This suggests that the Asian-American participants processed the stimuli more holistically than the European-Americans did.

Culture can also influence attentional processes through one's genes. Kim et al. (2010) genotyped both Korean and European-American participants and examined their tendency to localize attention to central objects or their surrounding contexts. Consistent with the research reviewed above, the Korean participants paid more attention to the object's context than European-American participants did. Interestingly, however, individual differences in a specific serotonin receptor called 5-HT<sub>1A</sub> moderated this difference. Specifically, participants possessing the 5-HT<sub>1A</sub> allele associated with reduced adaptability were more likely to exhibit a culturally-stereotypical locus of attention (i.e., to the context among the Koreans and to the object among the European-Americans), demonstrating an interaction between the perceiver's culture and his or her genetic makeup.

## **Social Processes**

### **Impression Formation**

Research on cultural differences in visual processing also extends to more complex, socially-embedded, and ecologically-valid targets, such as judgments about people's traits, thoughts, and social behaviors. Surprisingly, however, several studies have shown remarkably few differences across cultural groups for trait inferences. For example, Albright et al. (1997) found that American and Chinese perceivers agreed about the extraversion and agreeableness of both American and Chinese individuals based on photographs. In another study, Zebrowitz, Montepare, and Lee (1993) found significant agreement across American and Korean judges' ratings of the facial maturity and attractiveness for American, Korean, and African-American targets. Similarly, Rule, Ambady, et al. (2010) found that American and Japanese perceivers



agreed in their impressions of the warmth and power of political candidates in U.S. and Japanese elections.

Although perceivers from different cultures might agree on the impressions formed of others, how people use or apply these impressions can differ across cultures. For example, although Zebrowitz et al. (1993) found that White American, Black American, and Korean perceivers all agreed on the attractiveness of the targets, they associated these impressions of attractiveness with perceptions of other traits in distinct ways. Specifically, White perceivers viewed attractive targets as more interpersonally warm regardless of their race, whereas Korean and Black raters only associated attractiveness with warmth for White and Black targets, respectively. Similarly, the American and Japanese participants in Rule, Ambady, et al.'s (2010) study agreed in their perceptions of warmth and power, but interpreted the meaning of these traits differently depending on the leadership norms of their culture. That is, American participants were more likely to vote for candidates they perceived as powerful, whereas Japanese raters were more likely to vote for candidates they rated as warm. Moreover, these differences aligned with how the voters in each nation actually behaved: powerful-looking candidates actually won their electoral races in the U.S., whereas warm-looking candidates won their electoral races in Japan. Both groups of raters showed similar amygdala responses when making these judgments, however, suggesting that the amygdala may service impression formation rather than reflect voting decisions (Rule, Freeman, et al., 2010). These results demonstrate that cultural values about leadership not only manifest in “zero-acquaintance” judgments, but also correspond to the real-world behavior of voters.

The cultural values illustrated in the aforementioned studies also impacted neural responses in a separate study. Freeman, Rule, Adams, and Ambady (2009) found that Japanese

and American perceivers agreed about the extent to which targets looked submissive or dominant, but processed the cues to these traits differently according to the values of their culture. Japanese individuals had a greater response in areas of the brain known to process rewards (e.g., the caudate nucleus and medial prefrontal cortex [mPFC]) when viewing images of bodies posed to look submissive. In contrast, American perceivers showed activation in these areas when viewing the same targets posing as dominant rather than submissive. This difference corresponds to the values of the two cultures, as the norms of Japan typically encourage deferent behavior whereas norms in the U.S. tend to prize assertiveness. Moreover, individual differences within the two cultures also indexed these distinctions. Participants who reported more endorsement of dominant behaviors and values showed a greater response in these reward-related brain areas for dominant versus submissive stimuli.

### **Mental State Inferences**

In addition to learning about people by judging their traits, people also form impressions about the mental states of others based on small bits of information (Mitchell, 2006). These inferences accumulate both from firsthand information (i.e., our own perceptions) and through the information and experiences that others recount to us. One method used to test people's "theory-of-mind" (i.e., their ability to infer others' mental states) is the false-belief task in which one reads about a story character who has less information about a situation than the reader, with the reader subsequently asked to guess the character's thoughts (Wimmer & Perner, 1983). One false-belief scenario, for example, describes a protagonist who places an object in one location and leaves the scene after which another character transfers the object to a different location without the first character's knowledge. Children who indicate that the protagonist will look in the new (moved) location upon return have not yet developed a theory-of-mind, as they fail to

distinguish their own knowledge and perspective from that of the protagonist. Although people differ in the extent to which they exhibit theory-of-mind capabilities (e.g., Baron-Cohen, Wheelwright, & Jolliffe, 1997), group-level cultural differences may exist as well (if only at the neural level).

Indeed, Kobayashi, Glover, and Temple (2006) investigated this question using fMRI and a false-belief task, finding that culture did not affect the accuracy of theory-of-mind judgments. These same judgments, however, were associated with culturally-distinct patterns of neural activity. Whereas both American and Japanese participants displayed similar activations in a host of relevant brain regions (e.g., right anterior cingulate cortex, dlPFC—areas often involved in error-monitoring and control), the Americans had more activation in areas associated with inferences about others (e.g., the right insula and bilateral temporo-parietal junction [TPJ]). In contrast, the Japanese participants had more activation in areas often implicated in decision-making (e.g., right orbito-frontal gyrus and right inferior frontal gyrus). It appears that culture may influence how people process mental states, with similar findings in children suggesting that the neural basis for theory-of-mind judgments may be molded by a person's first language or early cultural environment (Kobayashi, Glover, & Temple, 2007).

People also infer others' mental states by observing subtle nonverbal cues. We can, for example, understand a lot about what people are feeling by paying close attention to their eyes (Baron-Cohen et al., 1997). Accordingly, one common measure of mental state reasoning is the Reading the Mind in the Eyes Test, in which individuals view images of the eye region of people's faces and guess what the target is thinking or feeling based on a short list of options (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). Researchers in one study developed a cross-cultural version of the Reading the Mind in the Eyes Test, adding novel East Asian stimuli

to the original Caucasian target set (Adams, Rule, et al., 2010). In doing so, they found evidence for an “in-group” advantage, such that Caucasian-American and Japanese participants more accurately judged the mental states of targets who belonged to their own culture. Moreover, although both groups displayed activation in the superior temporal sulcus (a brain region associated with inferring intentions; Allison, Puce, & McCarthy, 2000) this activation was greater when inferring the mental states of own-race targets. This suggests that cross-cultural misunderstandings could result from people processing the mental states of individuals from other cultures differently from the mental states of those from the same culture (Franklin, Stevenson, Ambady, & Adams, 2015). Similar to some of the past findings discussed above, this out-group disadvantage in mental state reasoning has also shown some evidence of attenuating as one adapts to a new cultural environment (Bjornsdottir & Rule, 2016). Thus, the capacity to understand the mental states of others may depend on one’s cultural exposure.

### **Emotions**

One component of inferring the mental states of others involves recognizing and interpreting their emotional states. People generally perceive the basic emotions of people from other cultures correctly. Like the in-group advantage in theory-of-mind judgments, however, people typically recognize the emotions of individuals from their own culture more accurately than they do the emotions of people from other cultures (Elfenbein & Ambady, 2002; Jack, Garrod, Yu, Caldara, & Schyns, 2012). Concomitantly, the neural activation associated with emotion identification is often stronger for cultural in-group members than for out-group members. For example, Chiao et al. (2008) showed that the amygdala (implicated in threat perception) responded more strongly to fearful in-group (vs. out-group) faces among both Caucasian and Japanese participants. Subsequent studies have reported that this difference varies

as a function of the targets' eye gaze, with the amygdala showing a stronger response to averted-gaze in-group eyes but direct-gaze out-group eyes in fearful faces (Adams, Franklin, et al., 2010). This may be because fear in an in-group member looking elsewhere signals threats more relevant to the self than does fear in an out-group member. In contrast, direct-gaze displayed by an out-group member may itself seem like a threat signal because it communicates that one is the target of an unfamiliar person's attention; thus, direct gaze may logically pair with anger (Adams, Gordon, Baird, Ambady, & Kleck, 2003).

Personality traits can also affect how one reacts to emotional faces. For example, participants in one study viewed faces exhibiting fear, anger, happiness, or a neutral expression while being scanned with fMRI, after which they completed a self-report measure of trait anxiety (Mujica-Parodi et al., 2009). More anxious individuals exhibited a range of different neural responses compared to those lower in anxiety, perhaps best interpreted as prolonged emotional processing of the neutral faces. This aligns with the idea that anxious individuals more closely monitor potential threats (e.g., Choi, Padmala, & Pessoa, 2012), with the neutral faces being more ambiguously threatening than the faces exhibiting clearly positive or negative emotions.

In addition to recognizing others' emotions, it is important to also regulate one's own emotions to effectively navigate interpersonal interactions. Different cultures vary in their norms for emotion regulation, which subsequently influences the neural instantiation of attempts to control emotional responses (Matsumoto, Yoo, & Nakagawa, 2008; Murata, Moser, & Kitayama, 2013). For example, an EEG study demonstrated that East Asian participants decreased the extent to which they processed emotions during emotion regulation, whereas European-American participants showed no such attenuation—consistent with cultural norms (Kitayama, Mesquita, & Karasawa, 2006; Tsai, Knutson, & Fung, 2006). Importantly, biological factors also

govern emotion regulation, with genes affecting emotion regulation styles. For instance, culture can affect the expression of genotypes such that people who possess a particular allele of the oxytocin receptor gene OXTR rs53576 (linked to several social behaviors; J. Li et al., 2015) use culturally-normative emotion regulation styles more than individuals without this variant (Kim & Sasaki, 2012). Culture also affects one's sensitivity to emotional displays, in general. Cheon et al. (2013) found that Korean participants attended more to the perspective and needs of others when viewing scenes of people in emotional pain than Caucasian-Americans did, also exhibiting greater responses in a brain region involved in processing pain (i.e., the anterior cingulate cortex). This stronger response to emotional displays holds important implications for the influence of culture on empathy, suggesting that some cultures may encourage empathic responding more than others.

### **Empathy**

Empathy refers to the ability to understand and share another person's emotions and feelings (Preston & de Waal, 2002). Empathy thus relates to emotion recognition, with some evidence suggesting that cultural norms and values can affect one's empathic response. de Greck et al. (2012), for instance, found that German and Chinese subjects responded differently when empathizing with anger. Differences in dlPFC activity suggested that Chinese participants regulated their emotions better than German participants when asked to empathize with anger, consistent with the Chinese cultural value of preserving harmony and not indulging disruptive emotions (e.g., Safdar et al., 2009). German participants, however, showed greater activity in brain regions linked to understanding others' intentions (Britton et al., 2006; Lamm, Batson, & Decety, 2007), suggesting that they may have attempted to understand the target's anger by simulating his or her perspective while empathizing. German culture's relatively greater

tolerance of anger may partly explain this, in that the German participants may have been more inclined to interpret the anger rather than try to control it.

Culture also seems to guide who empathizes with whom. As cultures vary in their preference for social hierarchy, this preference affects individuals' empathy towards in-group versus out-group members. Cheon et al. (2011) reported that Korean participants felt greater empathy towards other Koreans than they did towards Caucasian-Americans when viewing members of each group experiencing emotional pain. Accordingly, they displayed stronger responses in brain regions associated with taking others' perspective (the bilateral TPJ) when viewing members of their own culture relative to those from another culture—not unlike the in-group differences observed for theory-of-mind described above. These differences also related to social hierarchy preferences. Specifically, greater responses to in-group members in the same brain region correlated with an increased preference for hierarchical social structures. This might be due to the association between hierarchies and the divisions between in-groups and out-groups. Caucasian-American participants who reported low social hierarchy preferences, however, did not show these differences in their empathic reactions toward members of the in-group versus out-group. Instead, they reported similar levels of empathy for both the Korean and Caucasian-American targets and showed a different pattern of responses in the same perspective-taking regions (i.e., no significant differences in the right TPJ but a stronger response to Korean targets' pain in the left TPJ). Another study found that Chinese adults who had spent a large portion of their lives in Western countries had similar neural responses to viewing Caucasian individuals experiencing pain as they did to Asian individuals experiencing pain, demonstrating again that exposure to a particular out-group culture may moderate cultural differences (Zuo & Han, 2013).

Within cultural groups, individuals can also differ in their ability to empathize with others and researchers have begun to investigate the brain regions that might underlie this variability. For example, the thickness of the cortex in a brain region closely linked to empathic reactions (the dorsal anterior insula; Lamm, Decety, & Singer, 2011) covaried with the thickness of other regions associated with emotion, social cognition, and executive control (right ventrolateral prefrontal cortex and anterior prefrontal cortex) as a function of self-reported trait empathy (Bernhardt, Klimecki, Leiberg, & Singer, 2014). In other words, individuals who rated themselves higher in empathy exhibited a network of brain structures more closely related in size for a set of brain regions previously linked to “in the moment” empathy for the pain of others. In addition, Parkinson and Wheatley (2014) found that higher trait empathy associated with stronger white matter connections between emotion-processing regions of the brain and areas linked to perception and action in a sample of Americans.

### **The Self**

One of the most studied areas of research in cultural neuroscience concerns people’s representations of the self versus others. Springing from classic work in cultural psychology, the lines that distinguish interdependent and independent cultures correspondingly impact how individuals think about themselves compared to other people. For example, Westerners tend to display stronger activations in the ventral medial prefrontal cortex (vmPFC) when reflecting upon oneself versus another person, implicating it in self-referential processing (Kelley et al., 2002). Subsequent work with Chinese participants, however, has reported similar patterns of vmPFC activation when people think about both themselves and their mothers (Zhu, Zhang, Fan, & Han, 2007), suggesting that people from more interdependent cultures may think about close



others as extensions of themselves. Notably, however, this shared self-representation does not seem to include one's father or close friends (Wang et al., 2011).

Individual differences in the extent to which one endorses interdependent values influences the degree of self- and mother-driven activations in certain brain areas, demonstrating variability in how the brain represents the self and others even within a single culture (Chiao et al., 2010; Ray et al., 2010). Related to this, Chinese individuals who are bicultural with an independent culture can experience a shift in how they represent their mothers, depending on what is on their minds. Specifically, S. H. Ng, Han, Mao, and Lai (2010) found that the vmPFC response of bicultural Chinese participants showed overlap when thinking about oneself and one's mother if they had been primed with Eastern stimuli. In contrast, they showed separate responses in the mPFC when thinking about themselves versus their mothers when primed with Western stimuli. Self-other representation may therefore be susceptible not only to cultural differences but also to different frames of mind.

### **Personality Traits and Individual Differences**

Although we have described neuroscience research on a wealth of individual differences in the sections above (e.g., interpersonal dominance, empathy), much of the study of personality traits focuses on the Five Factor Model (e.g., John & Srivastava, 1999). Accordingly, a great deal of genetic and neuroscientific work has investigated these traits (Allen & DeYoung, in press; DeYoung, 2010; Yarkoni, 2014). In addition, new trait theories have begun to incorporate the results of neuroscience and genetic research to provide a more complete model of personality processes, the formation of trait tendencies, and trait expression (e.g., DeYoung, 2015; Hirsh, Mar, & Peterson, 2012). In this last section, we discuss examples of how biological approaches to personality have served to elaborate the understanding of basic traits, with a focus on

converging evidence, meta-analyses, and studies based on large samples, all of which seek to overcome some of the challenges to this work described above.

Extraversion refers to a tendency to be both enthusiastic and assertive, with individuals high in extraversion likely to be sociable, outgoing, talkative, and opinionated (DeYoung et al., 2007). These qualities are more common in Western than in Eastern cultures (e.g., McCrae, Yik, Trapnell, Bond, & Paulhus, 1998) and all relate to sensitivity for reward, which in turn is associated with the function of the neurotransmitter dopamine (DeYoung, 2015). The link between extraversion and dopamine function is one of the most consistent findings in personality neuroscience, with supportive evidence appearing across a wide range of paradigms (Allen & DeYoung, in press). Some of this evidence comes from quite impressive studies boasting large samples (e.g.,  $N = 1093$ , for the EEG results of Wacker & Gatt, 2010). That said, the level of support for this link varies somewhat depending on the approach employed (Wacker & Smillie, 2015), which has motivated a call to further refine the characterization of exactly how the dopaminergic system supports extraversion. Dopamine may differentially contribute to the different sub-components of extraversion (e.g., its underlying aspects of enthusiasm and assertiveness) and may also contribute to trait openness and the higher-order trait that links openness with extraversion: plasticity (DeYoung, 2013, 2015).

Whereas extraversion is closely linked to reward sensitivity, the trait of neuroticism appears almost polar-opposite, describing a tendency to experience negative emotions and withdrawal-related reactions (e.g., sadness, worry), negatively valenced approach-related responses (e.g., anger), and emotional volatility (DeYoung et al., 2007). These all appear to reflect heightened threat sensitivity, with uncertainty posing one particularly salient form of threat (Hirsh et al., 2012). As strong support of this characterization, a meta-analysis of 729

studies found that higher levels of neuroticism predicted decreased cardiovascular reactivity and poorer cardiovascular recovery following stress (Chida & Hamer, 2008), providing a clear link to biological reactions to stressors. Cortisol, a hormone commonly associated with stress responses, would also seem to be a likely candidate for a neurobiological substrate of neuroticism. However, a meta-analysis examining 26 studies of the cortisol awakening response failed to find any association with neuroticism, anxiety, or negative affect in general (Chida & Steptoe, 2009). Intriguingly, a carefully controlled follow-up study confirmed this lack of association between neuroticism and the cortisol awakening response, but did reveal higher cortisol levels for individuals high in neuroticism for the remainder of the day (Garcia-Banda et al., 2014). This distinction between the cortisol awakening response and daily levels of cortisol highlights the necessity of choosing measures carefully when employing biological tools, as with other measures based on behavior or self-report. In addition to dopamine and cortisol, recent research has linked neuroticism with the short allele of the serotonin transporter gene (Minkov, Blagoev, & Bond, 2015), which previous studies have tied to cultural collectivism, as reviewed above (Chiao & Blizinsky, 2010).

It is important to keep in mind that single traits do not exist in isolation, which has clear implications for understanding the biological bases of these traits. People possess many traits and embody a number of distinct individual differences, with the expression of one likely to interact with the levels of others. Even seemingly basic individual differences, such as gender, might moderate the neurobiological substrates of individual traits. For example, in a study of resting EEG in 699 participants, Tran et al. (2006) found that associations between the Big Five personality traits and neural activity differed between men and women. Other gender differences in neurobiological substrates have also been observed, with associations between traits and the

volume of brain structures at times exhibiting opposite associations for women ( $n = 197$ ) compared to men ( $n = 156$ ; Y. Li et al., 2014). The fact that individual differences likely interact with one another in complex ways to make the identification of neural substrates somewhat difficult mirrors the obstacles facing those seeking to understand how genes contribute to traits. Specifically, whereas behavioral genetic studies find that personality traits and individual differences show at least moderate heritability (Bouchard & McGue, 2003), genome-wide association studies have struggled to find reliable associations between individual genes and particular personality traits (de Moor et al., 2012), likely because numerous different genes interact in complex ways to influence any individual trait in combination with environmental influences.

The neurobiology of individual differences aside from the Big Five traits has also been studied rather extensively. Individuals show differences in cognitive and perceptual styles, and these often relate to culture—as reviewed above. Another example of an individual difference moderated by culture is one's tendency to spontaneously infer traits from behavior. Na and Kitayama (2011) found behavioral and neural evidence that European-American participants were more likely to make spontaneous trait inferences than Asian-American participants. Culture-based differences in thinking about personality also extend to thoughts about one's own personality. Specifically, Sul, Choi, and Kang (2012) demonstrated that cultural orientation predicts neural activation when thinking about one's personality and social identity. In their study, collectivistic participants showed greater left TPJ activation during judgments of their own personality than individualistic participants did, but both individualists and collectivists showed similar activations when thinking about their social selves. These results suggest that the left TPJ may be involved in representing interdependent aspects of the self. Conversely,

individualistic participants showed increased mPFC activity compared to collectivistic participants while thinking about their social selves and higher right TPJ activity for both personality and social identity judgments. Sul et al. note that this aligns with previous evidence implicating the right TPJ in distinguishing the self from others, reasoning that the mPFC may represent independent aspects of the self.

### **The Value of Biological Approaches to Culture and Personality**

In this chapter, we have reviewed various studies at the nexus of cultural psychology, personality and individual differences, and cognitive neuroscience, but to what avail? That is, can cultural neuroscience contribute something unique that its progenitors have not? We would argue so. Specifically, the integration of biology into the study of culture and personality allows for a fuller account of how each element contributes to the mind, brain, and behavior. Cognitive neuroscience can help us better understand underlying processes behind cultural and individual differences. Even when outcomes look similar, the underlying paths leading to those destinations may differ (e.g., Kitayama & Murata, 2013; Kobayashi et al., 2006). Studying behavior alone may therefore fail to reveal important cultural or individual differences. Similarly, cultural and personality neuroscience can also inform cognitive neuroscience. The studies described above have shown how cultural or individual differences may moderate neural responses to sensory stimuli (e.g., Gutchess et al., 2006) as well as higher-level cortical responses (e.g., Adams, Rule, et al., 2010). Such findings leave little doubt that culture influences one's brain, encouraging cognitive neuroscientists to consider how participants' contexts and experiences might direct neural activity. Combining the methods and theories from cultural psychology and personality psychology with cognitive neuroscience can therefore mutually benefit all fields involved.

Stakeholders from all sides bring with them toolboxes foreign to the other, as well as important and unique ideas for achieving the best account of how cultures and brains interact and evolve.

### **Conclusion**

Although we have touched upon only a fraction of the findings wrought by cultural and personality neuroscience to date, this *amuse-bouche* of studies helps to showcase the benefits and reciprocal influence of these disciplines. The growing adoption of biological tools to study complex human phenomena such as culture and personality presents the chance to better understand how cultural and individual differences may affect cognition and behavior down to some of its most basic properties, clarifying basic theories and providing opportunities for meaningful application.

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