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REVIEW

How culture shapes social cognition deficits in mental disorders: A review

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ABSTRACT

Social cognitive skills are indispensable for successful communication with others. Substantial research has determined deficits in these abilities in patients with mental disorders. In neurobiological development and continuing into adulthood, cross-cultural differences in social cognition have been demonstrated. Moreover, symptomatic patterns in mental disorders may vary according to the cultural background of an individual. Cross-cultural studies can thus help in understanding underlying (biological) mechanisms and factors that influence behavior in health and disease. In addition, studies that apply novel paradigms assessing the impact of culture on cognition may benefit and advance neuroscience research. In this review, the authors give an overview of cross-cultural research in the field of social cognition in health and in mental disorders and provide an outlook on future research directions, taking a neuroscience perspective.

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Introduction

Social cognition plays a major role in an individual's ability to interact with its social environment. According to the definition of Lieberman (2007), social cognition is an umbrella term that usually subsumes concepts of understanding others, understanding oneself, controlling oneself and the processes that occur at the interface between self and others. It covers, for instance, a set of skills that relate to the identification and interpretation of emotions, for example, in facial expressions (Comparelli et al., 2013), but also to the inference of one's own and other people's mental states, the so-called mentalizing or theory of mind (ToM) (Blakemore et al., 2003). Research in clinical populations has shown that some mental disorders present with distinct deficits in social cognitive abilities, for instance affective and psychotic disorders (Hoertnagl & Hofer, 2014). Psychiatric symptomatology is considered an interplay between diseases, dimensions of personality, goal-directed behaviors and life stories (McHugh & Slavney, 1998). However, recently not only developmental and sociocultural factors have been intensively investigated; genetic, brain imaging and behavioral psychiatric research approaches have been joined to create modern research models of neurodevelopmental disorders (Deeley et al., 2014; Ma et al., 2014). Within this framework, cultural neuroscience approaches have focused on neuroplasticity as a

manifestation of sociocultural impact on the brain. The study of the phenomenology of psychiatric symptoms in different cultural environments might contribute critical information to what is already known about healthy individuals, both in terms of mind and behavior, as well as in terms of how the brain mediates culture–mind interactions in the extremes of normalcy and disease.

This article will provide an outline of cross-cultural differences in social cognition, targeting psychiatric symptomatology in affective and psychotic disorders. To create an understanding for the background of sociocultural differences and for a better understanding of pathologic states, we will include a brief introductory overview of the data on neurophysiological development and cross-cultural differences in social cognition in healthy individuals. We will then summarize recent neuroscientific approaches in cross-cultural social cognitive research and will link these findings to clinical applications and to future research directions.

Culture and the brain

Impact of culture on social cognition

After learning the basic rudiments of emotion and self/other distinction, children start to acquire social cognitive skills which are impacted strongly by culture (Callaghan

et al., 2011). The subsequent developmental differences in social cognitive skills relate to more complex abilities such as mentalizing (Wellman, Cross, & Watson, 2001). For instance, North American children have been described to develop an early understanding of the fact that two individuals (with desires) might have differing beliefs (Wellman, Fang, Liu, Zhu, & Liu, 2006). Chinese children, on the other hand, seem to understand earlier that individuals may be knowledgeable or ignorant of facts and situations, irrespective of their beliefs or desires. Naito and Koyama (2006) found that Japanese children develop false-belief skills later than Western children, but had better skills at interpreting situations, strongly depending on the inference of implicit social information. These differences may be fostered by educational styles, for example, early social training (see e.g., Hendry, 1986), differential use of mental state terms (Lee, Olson, & Torrance, 1999; Wellman et al., 2006) and literacy of parents (Li & Rao, 2000). Kobayashi, Glover, and Temple (2007) suggest that neural correlates of ToM may begin to vary depending upon cultural/linguistic background early in life. In their functional imaging studies employing ToM tasks, several brain regions (inferior frontal gyrus (IFG) and temporo-parietal junction (TPJ)) were employed in a culture- and/or language-dependent manner.

It has been proposed that equal performance levels on social cognitive tasks across cultures are reached in adulthood (Wellman et al., 2001). Also, universality of facial emotional expression recognition (Brandt & Boucher, 1985) as well as the ability to identify particular emotions (Ekman & Friesen, 1971; Ekman, Friesen, & Ellsworth, 1972) has been described. However, cultural variations exist that may relate to different societies' sanctions and appraisals of specific emotional expressions (Markham & Wang, 1996). Certain societies, for instance the Japanese, may perceive the open expression of emotions as too strong or inappropriate (Aune & Aune, 1996). Ratings of emotional intensity can accordingly vary across cultures (Ekman et al., 1972; Matsumoto & Ekman, 1989; Matsumoto et al., 2000). East Asian individuals have also been shown to process emotional face information differently, judging from the fixation patterns in faces of others (Blais, Jack, Scheepers, Fiset, Caldara 2008), which suggests a biological basis for social cognition performance differences. In non-Asian cultures, a tendency toward a more self-centered (individualistic) perception of one's social surroundings has been substantiated, while Asian cultures are likely to perceive social information in a contextual, interpersonal way (collectivistic) (Triandis, 2001). The tendency of Asian individuals to predominantly interpret the (emotional) contents of a situation may be connected to their group-focused view of personhood

(Shweder et al., 1998). This might explain the finding that for example, Japanese participants make more statements about contextual information and relationships than American participants do (Matsuda & Nisbett, 2001), while North Americans seem to ignore contextual information when making judgments (Kitayama, Duffy, Kawamura, & Larsen, 2003).

In summary, normal development in social cognition is based on culture-dependent strategies in education, language use and behavior. Although some social cognitive processes are understood to be universal, there are certain cultural variations present that can be traced into adulthood. Biological reaction patterns, such as eye movement in reaction to social stimuli, suggest that cultural variations may impact on cerebral functioning from an early age.

Culture and mental disorders

Humans are a species of primate that has evolved to transmit large amounts of culturally encoded information. It is thus helpful to consider a concept such as "culture" in its evolutionary framework—that is, as a series of adaptations shaped by natural selection. Human mentalizing and intentional thinking may enable not only the copying of behavior, but also the innovation seen in many culturally transmitted tools and practices (Richerson & Boyd, 2005; Tomasello, 2000). These practices produce and sustain the flexibility that has allowed humans to inhabit a wide range of environments that are much more extensive and include a larger variety of extremes than those inhabited by our closest primate relatives (Richerson & Boyd, 2005; Tomasello, 2000). Is it possible that mentalism—an ancient adaptation that allowed us to coordinate action in large groups—also makes us prone to detecting intention and meaning all around us? Does it, perhaps, make us prone to psychosis?

For a better understanding of psychopathological processes, efforts have been made to describe psychopathological phenomena that are considered to be linked to ethnic-cultural characteristics or social conditions (Jilek, 1995; Yap, 1951). A variety of studies comparing symptom patterns, as for instance in descriptions of possession (Furukawa & Bourgeois, 1984; Mesulam, 1981), have been published which have since come to be known as comparative ethnopsychiatry or psychology. Symptom dimensions as functions of the sociocultural background of an individual have been found to be correlating more strongly with underlying neural organization than categorical constructs, such as disorders (Van Praag, 1990). When considering the benefits of comparative psychiatry in the understanding of symptom patterns, it should be

kept in mind that all societies arbitrarily define deviations in a distinct way and view symptoms and disorders against the background of what is considered to be normal in their culture (Murphy, 1976). Based on the DSM IV criteria, it has been shown that similar psychiatric diagnoses have been made across cultures (Australia, India, Malaysia) regarding their form, but where the contents of symptoms, for example, delusional symptomatology, is concerned, different subgroups need to be considered for specific cultures (McLean et al., 2014).

In the following section, we present important findings of symptom pattern variations between cultures for (major) mental disorders, followed by findings on social cognitive differences.

Psychotic disorders

While the prevalence of schizophrenia has been shown to maintain a constant rate across cultures, the course of the disorder has been shown to vary (Siegert, 2001). For example, patients with schizophrenia in developing countries seem to recover more quickly (Sass, 1997), with familial interdependency posing one protecting factor (Singh, Harley, & Suhail, 2013). More importantly for the present review, however, recent research has shown that symptom patterns vary according to cultural background (Koelkebeck & Wilhelm, 2014). In Western patients, religious delusions and delusional guilt (Tateyama, Asai, Hashimoto, Bartels, & Kasper, 1998; Tateyama et al., 1993), delusions of grandeur (Stompe et al., 1999) as well as of persecution (Minsky, Vega, Miskimen, Gara, & Escobar, 2003; Tateyama et al., 1998; Veling, Hoek, Selten, & Susser, 2011) have been shown to occur more frequently than, for example, in Asian and African cultures. Specific delusional contents can refer to political background (e.g., espionage in South Korea (Kim et al., 2001, 1993)), societal characteristics (e.g., strong will to avoid shame in Japan (Tateyama et al., 1998, 1993)), or cultural beliefs (e.g., fox demon possession in Japan (Omata, 1985)). Tactile hallucinations seem to occur frequently in patients from Africa and the Middle East, while in European countries visual hallucinations have been described as being most frequent (Ndeti & Vadher, 1984). Hallucinations have been found to be more persistent in African countries, while Latin-Americans report more somatic concerns (Bauer et al., 2011). However, cultural effects may not necessarily be delineated by geopolitical boundaries (Gecici et al., 2010) since symptom patterns seem to also depend on present living circumstances, as a study on immigrants to the U.K. who hallucinated in

English, and not their native language, showed (Suhail & Cochrane, 2002).

Affective disorders

The prevalence of affective disorders varies across countries (Weissman et al., 1996) and there is evidence for culture-specific symptomatology (Kleinman & Good, 1985). Cultural concepts of loss of control and attributional bias toward the self may impact depressive mood differently (Kirmayer & Groleau, 2001). Again, language may have an effect on the symptom dimensions of depression, as cultures have different idioms of distress (Kirmayer & Groleau, 2001). For example, individuals from Eastern, collectivistic cultures have been shown to report their symptoms in somatic and interpersonal terms as compared to Westerners, who use affective, existential, cognitive and somatic terminology (Marsella, 1980). Feelings of guilt and self-reproach also seem to vary at different investigation sites with the highest rates in Switzerland and Japan (Jablensky, Sartorius, Gulbinat, & Ernberg, 1981). In Japan, for instance, individuals are encouraged to attribute failure to themselves and success to the group (DeVos, 1985; Markus & Kitayama, 1991). In a Europe-wide study, Italian patients scored higher on ratings of hypochondria, motor retardation, hopelessness, loss of interest and dissatisfaction, while Swedish patients suffered from the inability to feel, weight loss, tachycardia and agitation (Perris et al., 1981). In British clinics, patients of African origin presented more often with manic symptoms and Afro-Caribbeans had more mood-incongruent symptoms (Kirov & Murray, 1999).

Culture-bound syndromes

Culture-bound syndromes are clinical presentation forms of symptoms that are culturally distinctive (Kirmayer, 2001). These syndromes offer insights into disorders which depend strongly on the sociocultural background of the individual. A classic culture-bound syndrome is koro, which is common in Southeast Asia as well as in China (Cheng, 1996). It implies the strong conviction that the male sexual organ is retracted inside the body (Freudenmann & Schonfeldt-Lecuona, 2005). A similar phenomenon has been described in India, with male patients fearing the loss of power due to the belief of losing their semen through premature ejaculation or from passing semen in their urine (Dhat syndrome (Sumathipala, Siribaddana, & Bhugra, 2004)). Taijin kyofusho is a phenomenon characterized by excessive nervousness and fear in social situations. While it has been described as a subtype of social

anxiety disorder (Kirmayer, 1991), it is particularly characterized by the fear to offend or harm others. This type of anxiety has been related to the Japanese culture with its specific value of consideration for others in social situations (Suzuki, Takei, Kawai, Minabe, & Mori, 2003). Another recently described phenomenon in Japan is hikikomori. It is defined as social withdrawal for more than 6 months. While it is suggested that hikikomori may be a representation of chronic schizophrenia, as patients sometimes show a strong immersion in personal interests (Teo & Gaw, 2010), cases with no subjective psychological distress have also been described. In these instances, patients have an apathetic lifestyle with no interest in hobbies of any sort (Kondo et al., 2013). Lifelong financial dependency seems relatively acceptable in Japan, which is why a strong impact on the development of hikikomori has been proposed. However, recent reports suggest that the so-called modern type depression, which has spread to other countries, is also a form of hikikomori (Kato, Shinfuku, Sartorius, & Kanba, 2011).

Behavioral findings

Little data is available on cross-cultural differences in the perception of social stimuli in patient groups, although abnormalities in self/other perception may form a model for the functioning of culture-based social cognition and vice versa (Fabrega, 1989). It has been shown that emotion recognition disadvantages in schizophrenia are similar across cultures (Lee, Lee, Kweon, Lee, & Lee, 2010). In contrast, schizophrenia patients of American-Caucasian origin have been shown to be more highly skilled at the perception of emotions as compared to samples of African- and Latin-Americans (Brekke, Nakagami, Kee, & Green, 2005). In a study on American, German and Indian patients with schizophrenia (Habel et al., 2000), Indian patients performed significantly worse than the other groups on an emotion discrimination task using Caucasian faces. A study using both Caucasian- and African-American facial stimuli demonstrated that patients with schizophrenia were more likely to recognize same-race than other-race faces (Pinkham et al., 2008). In two studies that assessed social cognition in relation to depressed mood in Greek (Bernieri & Gillis, 1993) and Northern American (Gillis & Bernieri, 1993) college students, dyadic interaction videos were presented. College students with depressed symptoms were shown to track female interaction partners to judge interactional contents. In a sample of Asian immigrants to the U.S. these immigrants tended to focus more strongly on affective components of depression than on somatic components

(Chen, Guarnaccia, & Chung, 2003). Furthermore, the level of self-attention has been identified as a mediator of cultural effects on depression.

To summarize, in mental disorders the main cultural differences are seen in the variation of symptom patterns, but distinct, culture-specific disorders have been described as well. These specific disorders might also be expressions of other mental disorders known in the Western world, for instance anxiety disorders in the case of hikikomori in Japan. Social cognition differences in mental disorders across cultures have rarely been investigated, but the few available studies indicate cultural variation which is more extreme in patient groups, and particularly exaggerated when stimuli with features of non-familiar groups, so-called out-groups, are involved.

Impact of culture on neuroplasticity

In recent research on social cognition, neuroimaging methods have been increasingly used to investigate its neuronal basis. While the available data on behavioral performance differences in social cognition in mental disorders are very limited, imaging findings are not available at all. In order to identify areas of research that might be applied to patient groups, we will summarize what has been found in the healthy population. As mentioned above, social cognition is a term that subsumes processes that occur at the interface between self and others (Lieberman, 2007). Since there is very little data available regarding social cognition in a narrow sense, for example, mentalizing or emotion identification skills, we applied the term social cognition in a broader sense, also including cognitive processes of self-/other concepts, empathy for pain as well as self-referential thoughts.

In healthy individuals, specialized cortical networks have been suggested to mediate social cognitive abilities, including the temporal, medial prefrontal (mPFC) and dorsolateral prefrontal (dlPFC) cortex as well as the amygdalae (Castelli, Happé, Frith, & Frith, 2000; Voellm et al., 2006). Cross-cultural differences in the mode and development of social cognitive abilities suggest that the brain might be activated in a culture-specific manner in response to social cognitive cues. Research focusing on the investigation of Caucasian and Asian groups in functional magnetic resonance imaging (fMRI) has created several hypotheses regarding possible activation differences across cultures. Some of the results can be directly linked to findings from physiological development, targeting self- and other concepts which relate to the views of the self versus the group in individualistic versus collectivistic societies.

First, different self-concepts have been proposed to affect cerebral activation patterns across cultures. On tasks assessing descriptions of the self, the mPFC and the cingulate cortex (CC) have been shown to be more strongly activated in Westerners and (bicultural) participants with individualistic traits (Chiao et al., 2009, 2010). Self-construal priming activated these brain regions culture dependently as well (Wang, Oyserman, Liu, Li, & Han, 2013). Judgments of the self versus public figures elicited greater activation in the TPJ in Chinese participants (Sul, Choi, & Kang, 2012). In an event-related potential (ERP) study, an advantage of self-recognition over other recognition has been ascribed to an enhanced self-focused attention of Western participants (Sui, Liu, Wang, & Han, 2009). Moreover, self-referential thoughts seem to activate different hubs of the resting-state network on the basis of individualistic versus collectivistic traits (Knyazev, Savostyanov, Volf, Liou, & Bocharov, 2012).

Second, different patterns of emotion recognition across cultures have been proposed to affect cortical activation. An fMRI study showed greater bilateral posterior superior temporal sulci (STS) recruitment during same-versus other-culture mental state decoding in both Japanese and Caucasian-American participants, using the reading-the-mind-in-the-eyes task with Caucasian and Asian stimuli (Adams et al., 2010). In a study using fearful facial stimuli, Japanese participants activated the right IFG, premotor cortex and left insula, while Caucasians activated the posterior CC, supplementary motor cortex and amygdala during task performance (Moriguchi et al., 2005). Authors hypothesized that Caucasians may respond to fearful faces in a more direct, emotional way, while Japanese people do not attach an emotional valence to faces. A study with German and Chinese participants on tolerance toward anger suggested that those with an independent lifestyle activate the right TPJ, right inferior and STS, as well as the left middle insula, while interdependent participants activate the left dorsolateral PFC (De Greck et al., 2012). Immordino-Yang (2013) studied how cultural effects in automatic neurobiological mechanisms may correspond to differences in the meaning individuals make of the social world and the self. In one study, the aspect of admiration and compassion in groups of Chinese, Asian-Americans and non-Asian Americans was investigated (Immordino-Yang, Yang, & Damasio, 2014). Different activation levels in the ventral (Chinese) and dorsal (non-Asians) insula in response to the presentation of videos displaying strength was related to visceral-somatosensory experiences. It was hypothesized that, on the one hand, calmer societies like the Chinese would rather rely on the modulatory role of the ventral insula, gaining insights in

the emotion strength by monitoring somatosensory properties. More active societies like the American, on the other hand, would rather pay attention to the somatosensory feelings gained, conveyed by the dorsal insula.

Intergroup empathy of emotional pain was assessed in Korean and Caucasian participants. Stronger activity in the left TPJ for in-group compared to out-group members was related to stronger empathy and greater preference for social hierarchy (Cheon et al., 2011). Moreover, higher values of other-focusedness were related to activation of the ACC and insula (affective pain matrix) and mPFC in Koreans (Cheon et al., 2013). In a study comparing Arabs, Israelis and South Americans regarding responses to the others' pain and emotional suffering, authors found that, behaviorally, participants reported less empathy toward the respective group they were in conflict with. Contrary to that, functional imaging results indicated less activation of the pain matrix and the mentalizing networks when a distant, non-conflict group was involved than in response to the conflict group (Bruneau, Dufour, & Saxe, 2012). On a ToM task involving biological motion, the mPFC as well as temporal parts of the brain were more strongly activated in Western than in Japanese participants. When autistic features and difficulties to identify feelings were present in Japanese participants, they showed a similar activation pattern to Western participants (Koelkebeck et al., 2011). Last, language education was proposed to affect social cognition-related brain activation. Comparing adult American monolinguals and Japanese bilinguals on a ToM task, only the Japanese participants activated the IFG (Kobayashi, Glover, & Temple, 2006).

To summarize, for its imaging studies in healthy individuals, research has concentrated mainly on the investigation of self- versus other cognition with a focus on the comparison between Western and East Asian societies. Mostly, findings suggest a culture-dependent activation in brain regions forming parts of specific networks in social cognition, with a stronger activation observed in Western participants. This has been attributed to stronger individualistic traits in Westerners.

Future research directions

The development of early detection tools as well as specific intervention programs to remediate social cognitive deficits is crucial to improving the lives in patients with mental disorders. Cognitive endophenotypes (Gur et al., 2007) can help identify persons at risk and assess therapeutical outcomes. Judging from the results of cross-cultural comparison studies, patient

groups display larger deficits, for instance in emotion identification, when stimuli of other cultural contexts are involved (e.g., Habel et al., 2000). In order to create more sophisticated tools assessing mental disorders, a cross-cultural stimulus context may thus be helpful, as this would provide a more sensitive measure than the stimulus sets that are currently used in emotion research.

Other race bias (Elfenbein & Ambady, 2003; Meissner & Brigham, 2001) suggests that own-race faces are remembered and discriminated better than other-race faces. Studies have shown that Caucasian individuals make different judgments about facial expressions when targets are either African-American or Caucasian (Hugenberg & Bodenhausen, 2003) and recognition is faster for positive emotions in Caucasian targets (Hugenberg, 2005). In a study introducing faces of women either covered by a traditional Islamic veil or wearing a cap and scarf, a sample of Western European descent recognized fear most quickly when the face was partly hidden by a niqab, while the cap-and-scarf condition was more often associated with happiness (Kret & de Gelder, 2012). Anxiety can lead to more stereotyped emotion attribution (Curtis & Locke, 2005), which is why tasks employing in-group/out-group stimuli including different race may be helpful in detecting emotion recognition abnormalities in patients with mental disorders which are characterized by high levels of anxiety.

Emotion perception is not only based on facial information (Hunt, 1941) but also on the body and the social context (Kret & de Gelder, 2010). Research has shown that facial expressions are better recognized when accompanied by a posture and vice versa (Kret, Stekelenburg, Roelofs, & de Gelder, 2013) and facilitated if expressions are dynamic rather than static (Kilts, Egan, Gideon, Ely, & Hoffman, 2003; Sato, Kochiyama, Yoshikawa, Naito, & Matsumura, 2004). In a study on individuals with autism spectrum disorder, patients failed to activate ventral visual areas and the mirror neuron system in response to body postures (Hadjikhani et al., 2009). A recent study showed that gaze avoidance does not necessarily relate to the general avoidance of another person's emotions (Mellings & Alden, 2000), but that highly socially anxious individuals gain an insight into other people's emotions by attending to alternative information sources, for instance, to expressive hands (Kret, Stekelenburg, de Gelder, & Roelofs, *in press*). In another study, violent offenders were investigated who had an attentional bias toward threatening body language rather than toward threatening facial expressions and who misinterpreted bodily expressions as being aggressive (Kret &

de Gelder, 2013). While some studies propose that, for example, neural responses to race during imitation of gestures and faces are driven by learned associations rather than by self-similarity (Losin, Cross, Iacoboni, & Dapretto, 2014); the above-mentioned findings suggest that in emotion research, the usage of naturalistic stimulus material including the whole body may also open the field for research on neuropsychiatric disorders.

Last, while emotion research has predominantly focused on explicit facial expressions in the past (de Gelder et al., 2010), a promising approach for patients with mental disorders might be the investigation of subtle emotion recognition (Burch, 1995; Tsui et al., 2013). The identification of these non-full-strength emotions can be considered to be even more difficult when displayed on a face of a person with a different cultural background (Matsumoto, 1992). Emotion recognition tasks that employ emotional ambiguity in faces with out-group features may therefore have advantages over conventional face recognition paradigms (Koelkebeck et al., 2015; Minoshita et al., 2005).

The outline of tasks that involve emotion identification from (ambiguous) faces with out-group features and body postures might form the basis of new assessment tools for mental disorders. The cultural context of the stimuli might be particularly helpful in targeting deficits, specifically in early intervention. It will be especially helpful to combine behavioral approaches with neuroscientific methods such as fMRI or eye-tracking. This might create tools not only to better understand the biological basis of social cognitive deficits in mental disorders, but might also help understand the source of deficits that could be targeted in specific training programs, such as the metacognitive training (Moritz et al., 2014).

Summary

Rather than viewing culture as a sphere that lies outside of biology, research converges toward the view that human brains evolved to receive and transmit large amounts of cultural information. Cultural viewpoints in psychiatric research are thus essential in refining our understanding of the biological and sociocultural factors affecting the development and course of diseases that, in turn, influence the onset, development, sustenance and configuration of neuropsychiatric disorders. Psychiatric symptoms in different cultural milieus can inform about the neuroanatomical and functional organization of the brain as the organ (or "acceptor") of culture. In addition, they might determine optimized diagnostic and intervention methods, answering the

question whether it is appropriate to apply the same treatment methods for mental disorders in different cultures (Han et al., 2013; Moritz et al., 2014). While little is known about the influence of culture on social cognition in pathological mental states, recent research has determined neural reaction patterns to social cues that relate to the sociocultural background of an individual. Culture-based social cognition may impact on the development of tasks assessing social cognition in patient groups utilizing stimulus material encompassing emotional face and body expression. Task designs that involve stimulus material featuring traits of culturally unfamiliar groups might be particularly helpful in this regard. More research is necessary, however, specifically in patient samples. Neurobiological investigation methods might complement these approaches and may also lead to a better understanding of cerebral functioning. Nonetheless, results need to be considered with great care, as other factors may be affecting results of cross-cultural studies. These include differences in health and lifestyles, education, task-dependent effects (Goh et al., 2010) as well as population-specific brain sizes (Knyazev et al., 2012).

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