Interpersonal Competence in Young Adulthood and Right Laterality in White Matter

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Abstract

■ The right hemisphere of the human brain is known to be involved in processes underlying emotion and social cognition. Clinical neuropsychology investigations and brain lesion studies have linked a number of personality and social disorders to abnormal white matter (WM) integrity in the right hemisphere. Here, we tested the hypothesis that interpersonal competencies are associated with integrity of WM tracts in the right hemisphere of healthy young adults. Thirty-one participants underwent diffusion tensor imaging scanning. Fractional anisotropy was used to quantify water diffusion. After the scanning session, participants completed the Adolescent Interpersonal Competence Questionnaire. Fractional anisotropy was subsequently correlated with Adolescent Interpersonal Competence Questionnaire scores using tract-based spatial statistics. Higher interpersonal competencies are related to higher WM integrity in several major tracts of the right hemisphere, in specific the uncinate fasciculus, the cingulum, the forceps minor, the infero-fronto occipital fasciculus, the inferior longitudinal fasciculus, and the superior longitudinal fasciculus. These results provide the first direct analysis of the neuroanatomical basis of interpersonal competencies and young adult self-reported skills in social contexts. ■

INTRODUCTION

Human beings are highly social animals, and in complex societies where social interaction is pervasive, nuanced, and extremely diverse, maintaining effective and sensitive social ties places a heavy burden on cognitive and emotional capacities of the individual. For example, developing and sustaining social relationships require competent and flexible social cognition, including the ability to represent relationships between oneself and others and the capacity to apply those representations to effectively guide social behavior (Adolphs, 2001). Indeed, these social cognitions are central to what Buhrmester (1990) referred to as "interpersonal competence," which encompasses the capacity to interact and communicate with others, to share personal views, to understand the emotions and opinions of others, and to cooperate with others or resolve conflict should it occur. Because these faculties constitute the building blocks of social relationships, interindividual differences in interpersonal competence are linked to social rejection and isolation among both clinical and nonclinical samples of children (Kully-Martens, Denys, Treit, Tamana, & Rasmussen,

2012; Ladd, 1999) and adults (Anders & Tucker, 2000; Phelps & Hanley-Maxwell, 1997).

During the transition to adulthood, when young adults must navigate a vast and complex array of novel social contexts with sharply varying social protocols, deficiencies in interpersonal competence are likely particularly problematic. That is, transitioning adults are said to be caught "in between" childhood and adulthood (Maggs, Jager, Patrick, & Schulenberg, 2012; Shanahan, 2000), and as a result, they face the difficult challenge of transitioning into adult settings (e.g., work) and into adult roles (e.g., spouse and parent) while maintaining, if not renegotiating, existing social ties from settings that are remnants of childhood (e.g., school/college, peer groups, the family of origin). Thus, deficits in interpersonal competence during young adulthood are associated with greater difficulty transitioning into college (Parker, Summerfeldt, Hogan, & Majeski, 2004; Mahoney, Cairns, & Farmer, 2003), work (Fitzgerald, Brown, Sonnega, & Ewart, 2005), and lasting romantic relationships (Collins & van Dulmen, 2006; Schneewind & Gerhard, 2002). Given the importance of interpersonal competence to young adult success and the fundamental roles that social and emotional cognition play in interpersonal competence, we were surprised to find that no social neuroscience studies have attempted to directly investigate brain mechanisms that underlie interpersonal competence. Because interpersonal competence entails the integration of cognitive and socioemotional resources, such as language processing,

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empathy, theory of mind, visual processing of socio-emotional cues, and working memory, there is reason to believe that brain networks are involved in the development and maintenance of interpersonal competence.

Brain regions link to each other through bundles of myelinated nerve cell processes (or axons), which carry nerve impulses between neurons and constitute the so-called white matter (WM). Associations of behavioral and personality traits with WM have received increasing attention (Kanai & Rees, 2011; Loui, Li, Hohmann, & Schlaug, 2011). WM integrity (Charlton, McIntyre, Howe, Morris, & Markus, 2007; Deary et al., 2006; Schmithorst, Wilke, Dardzinski, & Holland, 2005) or hyperconnectivity (Loui, Li, Hohmann, et al., 2011) are well-known key indicators of higher information-processing efficiency in cognition at every stage of human development. Therefore, in this study, we looked at WM correlates throughout the whole brain and examined whether individual differences in self-reported interpersonal competence relate to WM connectivity in a sample of healthy young adults. More specifically, given that several distinct lines of research have linked socioemotional cognitions to WM integrity in the right hemisphere of the brain, our main hypothesis was that interpersonal competence would be specifically associated with WM integrity in the right hemisphere.

Socioemotional Processing and the Right Hemisphere of the Brain

Individuals who are interpersonally competent are typically empathetic (Chow, Ruhl, & Buhrmester, 2013; de Wied, Branje, & Meeus, 2007) and display high levels of emotional intelligence, which includes the abilities to perceive, use, understand, and manage emotions (Brackett, Rivers, Shiffman, Lerner, & Salovey, 2006). Some components of empathy and emotional intelligence appear to reflect functioning of the human mirror neuron system (Parkinson & Wheatley, 2012; Iacoboni & Dapretto, 2006), and these aspects have been associated with the right hemisphere portion of the mirror neuron system (Cattaneo & Rizzolatti, 2009; Uddin, Iacoboni, Lange, & Keenan, 2007), which is believed to be central to understanding of self in relation to others. Additionally, social cognition has long been linked to right laterality (Frith & Frith, 2012; Semrud-Clikeman, Fine, & Zhu, 2011; Decety & Lamm, 2007; Devinsky, 2000; Winner, Brownell, Happe, Blum, & Pincus, 1998; Semrud-Clikeman & Hynd, 1990; Weintraub & Mesulam, 1983). Several comparative studies—some even involving phylogenetically distant species—indicate right hemispheric dominance in recognition of familiar social partners in processing information relative to other individuals as well as in the development of social competencies (Salva, Regolin, Mascalzoni, & Vallortigara, 2012; Vallortigara, 1992).

More specifically, abnormal WM integrity in the right hemisphere of the human brain has been linked to abnormalities in processing socioemotional information. For example, lesions in the right hemisphere are associated with deficits in social perception and understanding, such as recognition and expression of facial emotion (Montreys & Borod, 1998), affective prosody (Breitenstein, Daum, & Ackermann, 1998), and sarcasm (Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005). Right hemisphere damage is also associated with impaired communication (Bartels-Tobin & Hinckley, 2005), lack of empathy (Rankin et al., 2006), and the inability to attribute mental states, such as desires, intentions, and beliefs, to oneself and to others (Lombardo, Chakrabarti, Bullmore, & Baron-Cohen, 2011; Weed, McGregor, Feldbaek Nielsen, Roepstorff, & Frith, 2010; Happe, Brownell, & Winner, 1999). Moreover, there is evidence to suggest that the interpersonal impairments associated with Asperger's syndrome are the result of developmental abnormalities within the right cerebral hemisphere (Gunter, Ghaziuddin, & Ellis, 2002; McKelvey, Lambert, Mottron, & Shevell, 1995).

With respect to social cognition, several studies have identified the special role of the right pFC. For example, showing participants pictures of eyes expressing friendly or hostile emotions activates the right OFC (Wicker, Perrett, Baron-Cohen, & Decety, 2003). Additionally, Tranel, Bechara, and Denburg (2002) reported that patients with lesions in the right ventromedial pFC displayed impairments in interpersonal behavior, but that patients with similar contralateral left lesions displayed no such impairments in social behavior.

Guided by the extant literature, we hypothesized that interpersonal competence is associated with the integrity of WM tracts in the right hemisphere of healthy young adults. The methodology we adopted accords with lines of research that link complex information about personality or attitudes measured off-line with brain structures measured with neuroimaging (Kanai & Rees, 2011). Of course, complex functions associated with social cognition cannot be understood solely in terms of localization of specialized brain areas working in isolation. Rather, a fundamental aspect in neural networks is connectivity between components, which determines the efficiency of the network as a whole. This basic concept is reflected in brain anatomy in terms of integrity of WM fibers connecting cerebral regions. To test our main hypothesis, we evaluated interindividual differences in WM integrity using fractional anisotropy (FA), which provides information about the directionality of the diffusion of water molecules in the whole brain, and we then correlated this neuroanatomical information with an index of self-reported interpersonal competence as measured by the Adolescent Interpersonal Competence Questionnaire (AICQ; Buhrmester, 1990).

METHODS

Participants

Thirty-one healthy, right-handed young adults (20 men) participated. They ranged in age from 19 to 29 years

(M = 22.93 years, SD = 2.66 years). The study was approved by the University of Trento Ethical Committee, and all participants gave written informed consent.

Procedures and Measures

Image Acquisition

MR images were acquired with a 4T Bruker Medspec scanner (Bruker Medical, Ettlingen, Germany) using a birdcage transmit, eight-channel receive head coil (USA Instruments, Inc., Aurora, OH). Each participant underwent a T1-weighted structural image (3-D MP-RAGE, $1 \times 1 \times 1$ mm^3, repetition time = 2700 msec, echo time = 4 msec, flip angle = 7°, GRAPPA [generalized auto calibrating partially parallel acquisition] factor 2, inversion time = 1020 msec, bandwidth = 150 Hz/pixel, acquisition time = 5 min) optimized for maximal contrast to noise ratio between gray matter and WM at 4 T (Papinutto & Jovicich, 2008). In each session, a diffusion weighted image data set was also acquired with a twice refocused 2-D SE-EPI sequence (Reese, Heid, Weisskoff, & Wedeen, 2003) and the following acquisition parameters: repetition time = 7000 msec, echo time = 85 msec, GRAPPA factor 2, voxel size = $2.5 \times 2.5 \times 2.5$ mm^3, b value = 1000 sec/mm^2. Five images without any sensitizing diffusion gradient applied (b0) and 30 diffusion weighted images with diffusion gradients applied along unique directions that were defined by an electrostatic repulsion algorithm (Jones, 2004; Jones, Horsfield, & Simmons, 1999) were acquired, with an axial slice acquisition along

the x–y plane of the static magnetic field reference frame. A field of view of 240 mm^2 and 50 contiguous slices enabled our covering the whole brain. A full Fourier acquisition was used to reduce cardiac pulsation artifacts (Robson & Porter, 2005). The total scan time lasted 270 sec per acquisition.

Diffusion Tensor Imaging Preprocessing

All diffusion-weighted images were processed using tools from the FMRIB software library (FSL, version 4.1.5; www.fmrib.ox.ac.uk/fsl) running on a Linux operating system. First, the DICOM files were converted to the nifti format using an open source DICOM-to-nifti converter (www.mccauslandcenter.sc.edu/mricro/mricron/index.html). Then, each data set was corrected for head movement and eddy current distortions using an affine transformation of each diffusion weighted image and b0 image to the first b0 image, used as reference. Second, a binary brain mask was generated from the non-diffusion weighted image by using the BET brain extraction tool (Smith, 2002). Following these steps, a diffusion tensor model was fitted independently for each voxel within the brain mask, and images of FA were generated for each participant. FA describes the degree of anisotropy of the water diffusion within a voxel and is considered a reliable index of microstructural integrity of WM and a measure of directional strength of the local tract structure. FA values range from 0 (minimum coherence in the WM structures) to 1 (maximum coherence in WM structures). As an additional test for the relative contribution

Table 1. Clusters Where FA and Interpersonal Competence Correlated Significantly ($p < .05$)

Cluster No.	Size (Voxels)	Corrected p Value	Peak x	Peak y	Peak z	Hemisphere and Lobe	Tract Location
1	10786	.016	8	36	47	R frontal	CM
2	1123	.021	28	−89	−7	R occipital	ILF
3	864	.018	47	−50	0	R temporal	SLF
4	351	.028	35	−28	−23	R temporal	ILF
5	143	.028	54	−20	1	R temporal	ILF
6	115	.028	44	−17	−17	R temporal	ILF
7	80	.028	44	−32	10	R temporal	ILF
8	64	.029	58	−36	17	R temporal	SLF
9	50	.021	15	6	−19	R frontal	UF
10	14	.03	18	−102	8	R occipital	FMa
11	11	.03	45	5	−34	R temporal	ILF
12	9	.03	10	−83	30	R occipital	FMa

Larger clusters have smaller numbers (1–12). The column Size (Voxels) indicates how many voxels are contained in each cluster. The column Corrected p Value refers to the p value associated with the maximum "intensity" voxel within the cluster after correction for multiple comparisons using threshold-free cluster enhancement. The columns x, y, and z indicate the MNI coordinates of the maximum intensity voxel in each cluster; coordinates are expressed in standard space (mm). The last column reports the WM labels taken from the Johns Hopkins University WM tractography atlas. According to the atlas, the clusters contain voxels belonging to six WM tracts: UF, CM, forceps major (FMa), IFOF, ILF, and SLF.

of parallel diffusivity and radial diffusivity (RD) to FA, for each participant we separately computed mean diffusivity (MD), RD, and axial diffusivity (AD) globally in the whole brain. Additionally, we computed RD and AD locally in small ROIs selected around the central coordinates of the first five clusters reported in Table 1, and we summed the results. Voxelwise statistical analysis of the diffusivity data was carried out using tract-based spatial statistics (TBSS; Smith et al., 2006). TBSS is a technique that aims to improve the sensitivity, objectivity, and interpretability of analysis in multiparticipant diffusion imaging studies. TBSS has been proposed to reduce problems related to possible misalignment of different participants' coregistered data through an optimized nonlinear registration followed by projection onto an alignment-invariant tract representation. In this way, the TBSS method allows for valid conclusions to be drawn from the subsequent voxelwise analysis.

Briefly, TBSS for FA consists of the following steps: (1) identification of the most typical participant in the group as target for all the nonlinear registration. This participant is selected minimizing the amount of warping required for all other participants to be coregistered with the target. (2) Alignment of all participants' FA images to the target using both linear and nonlinear transformations (Andersson, Jenkinson, & Smith, 2007a, 2007b) and subsequent affine transformation to the standard Montreal Neurological Institute (MNI) space. (3) Averaging of the aligned individual FA image and generation of a skeleton representing WM tracts common to all participants. In our case, the mean skeleton image was created using an inferior FA threshold of 0.2. (4) Projection of each participant's aligned FA data onto the skeleton. (5) Group comparison using voxelwise cross-participant statistic.

Statistical Analysis

We performed cross-subject analyses to relate voxelwise measures of diffusivity values (FA, MD, AD, RD) to interpersonal competence using the general linear model tool in FSL in conjunction with permutation-based tests using Randomise (5000 permutations). The cluster size analysis results were corrected for multiple comparisons across space ($p < .05$) using threshold-free cluster enhancement. Clusters where local diffusivity measures differed as a function of scores in interpersonal competence were labeled using a stereotaxic WM atlas (Mori et al., 2008).

Interpersonal Competence

Interpersonal competence was assessed with the AICQ (Buhrmester, 1990), which has been widely used in young adult samples (Lopes et al., 2004; Daley & Hammen, 2002). The AICQ is a 40-item measure with five subscales: self-disclosure, providing emotional support to friends, management of conflicts, negative assertion, and initiation of friendships. Items were rated on a 5-point scale (1 =

Poor at this, would be so uncomfortable and unable to handle this situation that it would be avoided if possible; 5 = *Extremely good at this, would feel very comfortable and could handle this situation very well*). The total scale as well as the subscales all displayed excellent reliability (e.g., in each case, the Cronbach alpha was .85 or higher).

We used a composite measure of interpersonal competence that incorporated all five AICQ subscales. After calculating mean scores for each subscale, we conducted a confirmatory factor analysis within M*plus* (Muthén & Muthén, 1998/2009) that loaded each of the five subscale means onto a single latent factor. Using the FSCORE command within M*plus*, we then outputted the latent factor scores so that they could be used in subsequent analyses. This latent factor approach for calculating a composite AICQ measure is superior to merely calculating a global mean score (i.e., the mean of AICQ's 40 items), because only the latent factor approach adjusts for measurement error and thereby increases both power and measurement reliability (Kline, 2010).

Identification of WM Tracts

Identification of WM tracts in which there was a correlation between AICQ and diffusivity measures (FA, MD, AD, RD) was based on the Johns Hopkins University WM tractography probabilistic atlases, available within the FSL toolboxes (Hua et al., 2008; Wakana et al., 2007). These atlases allow voxel-by-voxel categorization to different major WM tracts within certain probabilities.

RESULTS

Voxelwise analysis in TBSS revealed significant differences within participants in mean FA indicating that higher interpersonal competence—as measured by the AICQ (Buhrmester, 1990)—is correlated with higher WM integrity ($p < .05$, corrected). We hypothesized that the difference in WM integrity should be localized exclusively in the right hemisphere (Figure 1). Specifically, higher FA values were found in voxels belonging to six major WM tracts of the right hemisphere: the uncinate fasciculus (UF), the cingulum (CM), the forceps minor (FM), the infero-fronto occipital fasciculus (IFOF), the inferior longitudinal fasciculus (ILF), and the superior longitudinal fasciculus (SLF). The significant voxels obtained from the voxelwise TBSS analysis were grouped in clusters and are reported in Table 1.

The global TBSS analysis of MD, AD, and RD showed no significant correlation with AICQ ($p < .05$, corrected). Without the correction for multiple comparisons, too conservative to evidence effects on the three metrics, RD showed a significant correlation with the AICQ in many voxels ($p < .05$, uncorrected). An additional local analysis of relative contributions of parallel diffusivity and RD to FA within the first five clusters reported in Table 1 showed that AD and RD values were both anticorrelated

Figure 1. Coronal, axial, and sagittal views (from top to bottom) of the *t* statistics map of FA comparison between participants (*p* < .03 corrected). The background image is the MNI template. Red voxels represent regions in which higher FA values are associated with higher scores in AICQ. The images are reported in the neurological orientation (left side of the brain is on the left of the coronal and axial views). Some of traits include FM, SLF, ILF, and CM, all in the right hemisphere. *x*, *y*, and *z* coordinates are based on the atlas of the MNI.
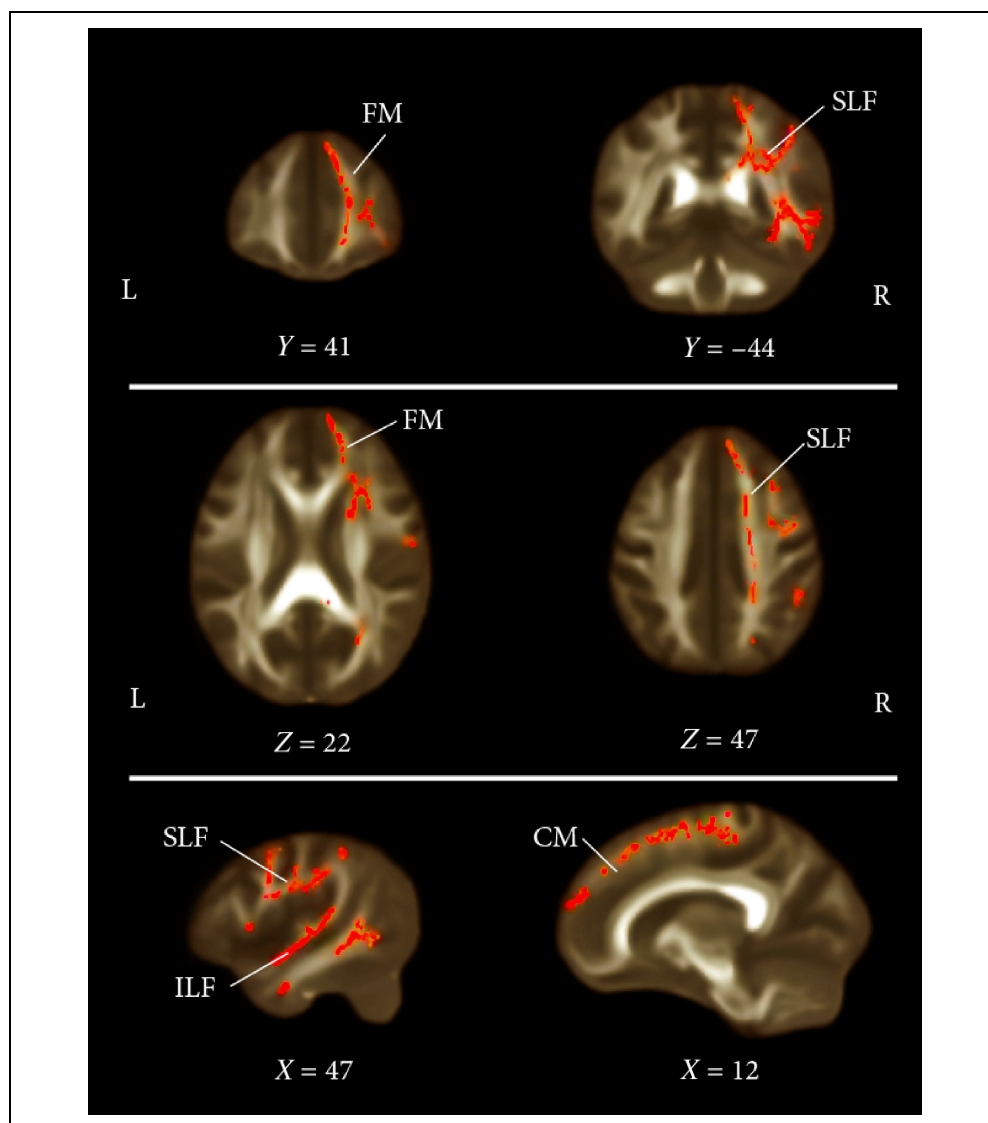
to the AICQ measure (see Figure S1). This result was more evident for RD (*r* = −0.62, *p* = .00019) than for AD (*r* = −0.31, *p* = .093).

DISCUSSION

The main goal of this study was to investigate associations between interpersonal competence of healthy young adults and their WM structural connectivity. Given that interpersonal competence depends on the integration of cognitive, affective, and social competencies, it is presumably served by distant brain regions working in concert. We hypothesized that interpersonal competence would be associated with higher integrity of WM pathways connecting distant brain regions in the whole brain. Specifically, in line with other behavioral, neuroimaging, and lesion studies that identify right laterality in social competence, we expected to find more pro-

nounced associations of social competence with WM integrity in the right hemisphere. Here we found that increased FA was associated with greater social competence in specific clusters identified using probabilistic atlases. Additional local RD and AD diffusivity analyses in the first five clusters reported in Table 1 suggest that this result is primarily driven by a negative correlation between RD and the AICQ. RD, like FA, is a parameter that is generally linked to myelination and axonal packing, whereas AD can vary with fiber diameter and axon coherence (Song et al., 2005; Beaulieu, 2002; Takahashi, Ono, Harada, Maeda, & Hackney, 2000). Thus, in several studies (Lebel & Beaulieu, 2011; Lebel, Walker, Leemans, Phillips, & Beaulieu, 2008; Eluvathingal, Hasan, Kramer, Fletcher, & Ewing-Cobbs, 2007; Mukherjee et al., 2001), longitudinal increases of FA, paired with reductions of RD and AD remaining constant, have been interpreted in terms of an increase in myelination from childhood into adolescence and young adulthood. Therefore, our

results suggest that interpersonal competence might be associated to greater integrity of WM pathways connecting distant brain regions in the whole brain, possibly because of more complete maturation of WM in terms of increased myelination into young adulthood. In particular, we found that AICQ correlated with several major tracts of the right hemisphere, including the UF, the CM, the forceps minor, the IFOF, the ILF, and the SLF.

The anatomical structure of these tracts connects several regions, which form the neural basis of several cognitive, emotional, and social functions, such as perception, language, modulation of social stimuli, auditory and visual association cortices, executive functions, and emotion regulation, all of which are of great relevance to interpersonal competence. We discuss these WM tracts and their functions in greater detail and how efficiency in these pathways indicates prioritized information processing of interpersonal and social competence.

The UF connects the OFC, the hippocampus, and the amygdala (Mori et al., 2008). Given that the UF is a part of the limbic system (Hasan et al., 2009; Catani, Howard, Pajevic, & Jones, 2002), its major purpose is believed to lie in emotional functioning, in particular sharing affective states, which typically characterizes empathy (Decety & Svetlova, 2012). Disruption of the UF tract in people affected by autism spectrum disorder (Ameis et al., 2011) has further confirmed its association with socioemotional behavior.

The CM connects the cingulate gyrus to the entorhinal cortex, facilitating communication between sections of the limbic system (Mori et al., 2008). It has been identified with processing emotional information as well as performing error monitoring in the service of cognitive control (Metzler-Baddeley et al., 2012). Specific right CM lesions have been found to relate to impaired social functioning in children (Angelini, Mazzucchi, Picciotto, Nardocci, & Broggi, 1981).

The FM is a part of the anterior region of the corpus callosum. In particular, it connects—via the most anterior part of the corpus callosum (the genu)—orbitofrontal areas involved in emotional and executive control (Park et al., 2008), which is a fundamental function in socioemotional competence.

IFOF and ILF jointly connect occipital and temporal cortices, and IFOF also connects with the frontal lobe and the posterior part of the parietal lobe (Mori et al., 2008). Thus, they are two of the largest and longest association fiber bundles in the human brain. Damage to these long association fibers has been linked to impairment in processing visual emotional cues (Bauer, 1982) and facial expressions of emotions (Philippi, Mehta, Grabowski, Adolphs, & Rudrauf, 2009; Thomas et al., 2009). Damaged ILF has also been associated with autism spectrum disorder (Cheung et al., 2009).

The SLF is one of the major intrahemispheric pathways that connects parietal, temporal, and frontal lobes and is effectively a bundle of fibers carrying most high level processing of information taking place in the human brain (Mori et al., 2008). The right SLF has been determined to be involved in processing tones and melodic information, particularly in pitch-based grammar learning (Loui, Li, & Schlaug, 2011), thus suggesting a major role of these connections in processing emotion and communication during language learning, development, and understanding others.

In overview, the most important finding to emerge in this study was that right lateralization in WM integrity is associated with interpersonal competence. This finding supports evidence in the literature that points to the fundamental role of the right hemisphere in social cognition (e.g., Frith & Frith, 2012). The finding may have implications for theories claiming that the right hemisphere plays a major role in modulating emotion and nonverbal communication during the first interpersonal relationship that every human being experiences, namely the infant–mother relationship (Schore, 1997, 2000, 2009). According to this line of research, the development of emotional and social intelligence in the individual—from childhood to adulthood—depends on the quality of their relationship with a principal caregiver and those socioemotional competencies heavily rely on right brain function. Our results support this hypothesis, highlighting the association between WM in the right hemisphere and interpersonal competence. Shore (2001) also suggested that dysfunction in the development of the right hemisphere might affect infant mental health and lead to psychosis and social difficulties in later stages of development. This suggestion might explain the large literature, which associates right hemisphere underconnectivity with personality disorder, and it is supported by evidence of reduced WM connectivity of the right hemisphere in animal and human studies with early deprivation of maternal care (Helmeke, Poeggel, & Braun, 2001) and orphanage care (Govindan, Behen, Helder, Makki, & Chugani, 2010).

Our study shows that WM integrity in several key tracts of the right hemisphere correlate with self-assessed interpersonal competence. Such individual differences might arise for a variety of reasons. They might be the effect of repeated behavioral patterns that favor interpersonal competence, as in continuous practice of those skills. This view is supported by several cognitive and affective neuroscience studies showing that the brain is highly plastic and that its interactions with the environment preserve gray matter from decaying (Pascual-Leone, Amedi, Fregni, & Merabet, 2005) and promote the formation of new and more efficient connections in WM (Scholz, Klein, Behrens, & Johansen-Berg, 2009). Alternatively, such individual differences in WM integrity might reflect genetic causes that predispose people to more effective interpersonal competencies. Finally, they might result from both experiences that simultaneously promote more effective interpersonal competencies and right hemisphere development (e.g., parenting or favorable economic circumstances).

Interpersonal competence is not an isolated function, but it is linked to a number of other cognitive and socio-emotional skills, such as language processing, empathy, theory of mind, visual processing of relational cues, and working memory. Thus, our finding that several major brain WM tracts are correlated with high levels of interpersonal competence should not be taken as indicative that these connections are specific or exclusive to this function; on the contrary, these are key fiber bundles, which play fundamental roles in other domains. Additionally, given the complexity of interpersonal interactions and the number of different factors that play important parts in them (biological, cognitive, emotional, and social), further assessments of associations between interpersonal competence and brain structure call for longitudinal, multicultural, and additional functional neuroimaging investigations.

Acknowledgments

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