''I Know You Are But What Am I?!'': Neural Bases of Self- and Social Knowledge Retrieval in Children and Adults

Jennifer H. Pfeifer, Matthew D. Lieberman, and Mirella Dapretto

Abstract

■ Previous neuroimaging research with adults suggests that the medial prefrontal cortex (MPFC) and the medial posterior parietal cortex (MPPC) are engaged during self-knowledge retrieval processes. However, this has yet to be assessed in a developmental sample. Twelve children and 12 adults (average age = 10.2 and 26.1 years, respectively) reported whether short phrases described themselves or a highly familiar other (Harry Potter) while undergoing functional magnetic resonance imaging. In both children and adults, the MPFC was relatively more active during self- than social knowledge retrieval, and the MPPC was relatively more active during social than self-knowledge retrieval. Direct comparisons between children and adults indicated that children activated the MPFC during self-knowledge retrieval to a much greater extent than adults. The particular regions of the MPPC involved varied between the two groups, with the posterior precuneus engaged by adults, but the anterior precuneus and posterior cingulate engaged by children. Only children activated the MPFC significantly above baseline during self-knowledge retrieval. Implications for social cognitive development and the processing functions performed by the MPFC are discussed. ■

INTRODUCTION

The capacity to appreciate oneself as a distinct, unified, and enduring entity with abstract qualities such as intelligence and agreeableness is one of the most unique abilities of mankind. As might be imagined, however, the developmental trajectory to such an endpoint is rather prolonged. Classic social developmental approaches suggest that the foundations of our self-concepts are gradually built during the first two decades of life, through socialization processes and the assimilation of self-definitions provided by the groups with which we identify (Harter, 1999; Damon & Hart, 1988; Mead, 1934; Cooley, 1902; Baldwin, 1895). Several of these theorists have more specifically proposed that self-knowledge is gained by internalizing the perspectives that other individuals take on ourselves, or assimilating others' behaviors into one's self-concept, and therefore, social knowledge capacities may actually precede their counterparts targeted on the self (e.g., Mead, 1934; Baldwin, 1895). Thus, remove the impish refrain, ''I know you are but what am I?!'' from its sarcastic context, and the retort may quite aptly describe the budding state of self-knowledge in children.

This developmental perspective—that the self is, in essence, no different from other social beings we regularly think about—parallels one side of an ongoing neuropsychological debate about whether the self is ''special'' (Gillihan & Farah, 2005; Lieberman & Pfeifer, 2005; Ochsner et al., 2005). The controversy has extended across several domains of self-processing, such as visual self-recognition, agency, autobiographical memory, first-person perspective-taking, as well as the object of this study: self-concept, also referred to as self-knowledge. Supporting the position that the self is ''special,'' a number of neuroimaging studies have found that certain neural regions are more active during self-knowledge retrieval than other types of social or semantic retrieval tasks (e.g., D'Argembeau et al., 2005; Lieberman, Jarcho, & Satpute, 2004; Johnson et al., 2002; Kelley et al., 2002; Fink et al., 1996). These studies have asked adults to indicate whether trait words or sentences across a variety of domains describe themselves. Retrieving this kind of self-knowledge, in contrast to other tasks (e.g., social or semantic knowledge retrieval), has been associated with greater activity in the medial prefrontal cortex (MPFC; putative Brodmann's area [BA] 10), and often, the precuneus or posterior cingulate in the medial posterior parietal cortex (MPPC; BA 7 and 31) as well. Interestingly, the MPFC and the MPPC also have some of the highest resting metabolic rates in the brain and tend to transiently decrease during goal-directed activity that is not self-referential, leading some to suggest this indicates their role in self-relevant processing or

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University of California, Los Angeles

conscious experience of a ''self'' in relation to its environment during rest (e.g., Gusnard & Raichle, 2001).

On the other hand, several neuroimaging studies have not found activity in the MPFC or the MPPC unique to self-knowledge retrieval (e.g., Ochsner et al., 2005; Schmitz, Kawahara-Baccus, & Johnson, 2004; Kircher et al., 2002; Craik et al., 1999). In these latter studies, it was often the case that self-knowledge retrieval and control tasks (like retrieving knowledge about other social targets) engaged the MPFC and the MPPC to a similar extent. Such findings have been used to argue that self-knowledge processes may not differ from those supporting knowledge about other people, and that these midline cortical structures are critically involved in both social cognitive mechanisms (especially in understanding others whom are similar to ourselves; see Mitchell, Macrae, & Banaji, 2006; Mitchell, Banaji, & Macrae, 2005). Furthermore, the MPPC has been implicated in a variety of more general functions, including episodic memory, perspective-taking, and a sense of agency (e.g., Cavanna & Trimble, 2006; Ruby & Decety, 2004; Vogeley et al., 2001; Cabeza & Nyberg, 2000; Maguire, Frith, & Morris, 1999).

The consensus thus seems to be that the MPFC is indeed a region essential to self-knowledge processes (Heatherton et al., 2006), although it may also support our understanding of other individuals, and the MPPC is likewise implicated in both self and interpersonal understanding. However, it is currently unknown what neural systems support these socially significant processes during development. Developmental psychology suggests that there are numerous changes in the contents and processes of both self- and social knowledge during childhood. For instance, prior to approximately 8 or 9 years of age, children do not use psychological traits in the same manner as adults. Although younger children may be heard using trait words to describe themselves, they are not yet performing the same ''mental arithmetic'' as adults who are using trait words self-descriptively—namely, the integration of specific behavioral features of the self into higher-order generalizations of characteristics that drive behavior (for reviews, see Harter, 1999; Damon & Hart, 1988; Rosenberg, 1986). For instance, a young child may use the words ''smart'' or ''friendly'' but they usually reflect single instances of behavior; there is no evidence that the use of such trait words is based on perceptions of recurring attributes and behaviors. In addition, although children can label others' behavior appropriately using trait words prior to age 7, they tend to rely on global, evaluative inferences (e.g., ''good,'' ''bad'') rather than on traits to predict others' behavior until between 7 and 10 years of age (Alvarez, Ruble, & Bolger, 2001; Yuill & Pearson, 1998; Dozier, 1991; Rholes & Ruble, 1984). This suggests that young children's trait understanding of both themselves and other social targets is qualitatively less complex than that of adults before middle childhood.

Another level of complexity present in adult self-concepts emerges from cognitive advances facilitating integrative thinking, perspective-taking, and social comparison processes—all of which ultimately inform assessments of one's own competencies and attributes (Frey & Ruble, 1990; Damon & Hart, 1988; Fischer, 1980). Before children are 7 or 8 years old, they are likely to endorse only positive or only negative attributes about themselves (as well as other individuals; Harter, 1999; Saltz & Medow, 1971). For example, a young child might perceive herself as ''all bad'' if convinced that she possesses a single bad attribute such as ''unintelligent.'' Further, they are unlikely to endorse significant variability in their self-concept across different social roles and contexts prior to ages 9 and 10, an essential feature of adult self-concepts. That is, younger children report being good and bad in similar ways across domains, and these perceptions are less tightly yoked to objective variability in the individual's behaviors and attributes—whereas significant correlations between self-concepts and domain-specific outcomes (e.g., perceptions of reading abilities and grades in relevant coursework) tend to emerge during middle childhood, as correlations across domains of self-concepts also decline (Marsh, 1989; Marsh, Barnes, Cairns, & Tidman, 1984; Rholes & Ruble, 1984; Nicholls, 1979). This suggests that the evaluative content of children's self-concepts is also significantly less complex than that of adults prior to middle childhood.

What then is occurring in the brains of children as they reflect on their own selves, in comparison to thinking about the attributes of other people? To our knowledge, no neuroimaging study has been conducted examining self- or social knowledge retrieval processes in children, although several studies have looked at the neural bases of other aspects of social cognition (e.g., face and emotion processing; Wang, Dapretto, Hariri, Sigman, & Bookheimer, 2004; Monk et al., 2003; Thomas et al., 2001). Therefore, the primary goal of the current study was to examine task-related activity during self- and social knowledge retrieval in children, and to directly compare it to that of adults. We carefully selected children from a controlled age group (9- and 10-year-olds) whom we could be confident possessed conceptions of themselves and other individuals that shared certain critical features with those of adults. These features included the two aspects of complex self-concepts described in the introduction, namely, the use of traits as higher-order generalizations of specific behavioral features and predictors of future behavior, as well as the ability to recognize variability in the valence of these evaluative attributes across domains. According to behavioral research summarized above, these features of self-concepts are acquired by approximately 9 or 10 years of age. During this time, children's behavior would thus look highly similar to that of adults, but adults are likely to be more efficient (faster) at self-knowledge retrieval than children due to greater expertise. Although populations of younger and older children may also provide interesting data, 9- and 10-year-old children constitute a good comparison group for an initial investigation because their self- and social knowledge can be considered ''complex'' in ways that are qualitatively similar to that of adults, but they are by no means ''experts'' in self- and social perception.

The task was designed to closely parallel those used in previous studies with adults. In two blocks, participants indicated whether short positive and negative phrases about academic skills and social competence described them. These phrases were tailored to children's early educational contexts and were compiled from existing scales of self-concept development assessing these domains (e.g., Eccles, Wigfield, Harold, & Blumenfeld, 1993; Marsh, 1990; Harter, 1985). These two self-knowledge blocks were alternated with two similar (social knowledge) blocks, during which participants indicated whether these same phrases described a fictional, highly familiar other: Harry Potter. Based on previous research in adults, we hypothesized that the MPFC and the MPPC would be involved during self-knowledge retrieval in both adults and children, but possibly also during social knowledge retrieval. We hypothesized that there would be developmental differences in these neural patterns such that children may demonstrate greater MPFC activity than adults during one or both of these processes, based on a recent study which demonstrated that reasoning about the communicative intentions of others elicited greater MPFC activity in children than in adults (Wang, Lee, Sigman, & Dapretto, 2006). Due to a lack of research directly examining self- or social knowledge retrieval in children, and the use of a conceptually different social target than in previous research, more specific hypotheses were not formulated in advance.

METHODS

Participants

Twelve typically developing children (6 boys, 6 girls) were recruited from the greater Los Angeles area via summer camps, posted flyers, and mass mailings. Twelve normal adults (6 men, 6 women) were recruited from the UCLA graduate student population. The children ranged in age from 9.5 to 10.8 years ($M = 10.2$ years), and the adults ranged in age from 23.0 to 31.7 years ($M = 26.1$ years). Children had no history of significant medical, psychiatric, or neurological disorders on the basis of parental reports on a medical questionnaire, the Child Behavior Checklist (Achenbach & Edelbrock, 1983), and a brief neurological exam (Quick Neurological Screening Test II; Mutti, Sterling, Martin, & Spalding, 1998). Written informed consent was obtained from all participants, as well as written informed parental consent for child participants, according to the guidelines set forth by the UCLA Institutional Review Board.

Materials

The functional magnetic resonance imaging (fMRI) stimuli consisted of short phrases that were generated by modifying items taken from existing scales of self-concept development, including the Harter (1985) Self Perception Profile for Children, the Marsh (1990) Self Description Questionnaire I, and the Childhood and Beyond Study (see Eccles et al., 1993). The phrases assessed two domains of self-concept, social and verbal–academic competence, which were represented in equal numbers of positively and negatively valenced items. More than 80 phrases were initially generated and then rated by 12 undergraduate students on a 5-point scale, according to how stereotypical the phrase was of four categories created by crossing domain with valence (i.e., a popular child, an unpopular child, a child with good verbal–academic skills, and a child with poor verbal–academic skills). Mean ratings were calculated and then used to select the 40 items (10 for each of the 4 categories) that were highly stereotypical of only one category, and not stereotypical of the remaining three categories (i.e., items that received scores of >4.25 in one category, and <2.75 in the other categories; internal consistencies were acceptable for all four scales and ranged from $\alpha = .71–.91$). Average word frequency and number of syllables per phrase were calculated using the MRC Psycholinguistics database (www.psy.uwa.edu.au/mrcdatabase/uwa_mrc.htm) and found to be statistically equivalent across all four categories. Sample phrases included: ''I am popular,'' ''I wish I had more friends,'' ''I like to read just for fun,'' and ''Writing is so boring'' (see Supplementary Information for a list of all stimuli used). Child and adult participants both varied widely on which phrases they endorsed, suggesting that social desirability had little effect on their responses, as the stimuli were equally split between positive and negative valence.

Experimental Procedure

While being scanned, participants responded (yes/no) using a button box to auditory presentation of the phrases via headphones (Resonance Technologies). One phrase was presented every 3 sec, and responses as well as latencies were recorded using MacStim 3.2 (WhiteAnt Occasional Publishing, www.brainmapping.org/WhiteAnt/). Phrases were approximately 1 sec long, leaving 2 sec for participants to respond. The 40 phrases were organized into four blocks of 20 stimuli each, such that each phrase was used twice (once for each target—self or social), and the four task blocks alternated between reporting whether the phrase described oneself or a fictional, highly familiar other: Harry Potter. The order of blocks was counterbalanced between participants so an equal number of subjects in each group heard each of the four blocks first. The initial block was always followed by a block containing the same phrases but applied to the other target (self or social), and then the last two blocks contained the remaining phrases (applied to the self and social targets in the same order as the first two blocks). Each of the four blocks was 75 sec long, and included the 20 stimulus trials and 5 null events during which no phrase was presented. Although this is somewhat long for block durations, we constructed the design in this manner specifically to reduce potential task-switching costs for the younger participants. The experimental run was preceded by 21 sec of rest and followed by 24 sec of rest; 21 sec of rest separated each block.

Participants were verbally instructed on this task outside the scanner and prior to the initiation of the run, and then were reminded of these instructions at the start of each block during the run. Because the phrases were prima facie relevant to early educational contexts, adults were additionally instructed prior to the run to try to respond whether the phrases generally described them now, rather than during their early school years. In other words, adults responded to the phrases based on their current social and academic identities rather than relying on their memory of who they were during childhood. All adults reported after the run that the phrases were easily interpretable in their current contexts.

Prior to the scan, it was ensured that all participants (both children and adults) had some familiarity with Harry Potter based on self-reports of knowledge about him on a 5-point scale (*M*s = 3.8 and 3.6 for children and adults, respectively). These reports of familiarity did not differ between children and adults [$t(22) = 0.7$, *ns*]. Objectively, each participant reported reading at least one book, or watching at least three movies, from the series. Children and adults also did not differ on their liking of Harry Potter [*M*s = 3.8 and 4.0 for children and adults, respectively, $t(22) = -0.6$, *ns*].

fMRI Data Acquisition

Images were acquired using a Siemens Allegra 3-Tesla head-only MRI scanner. A 2-D spin-echo scout (TR = 4000 msec, TE = 40 msec, matrix size 256 × 256, 4-mm thick, 1-mm gap) was acquired in the sagittal plane to allow prescription of the slices to be obtained in the remaining scans. The self-knowledge retrieval task consisted of one functional scan lasting 6 min and 45 sec, during which 135 images were acquired. These 135 images were collected over 36 axial slices covering the whole cerebral volume using a T2*-weighted gradient-echo sequence (TR = 3000 msec, TE = 25 msec, flip angle = 90°, matrix size 64 × 64, FOV = 20 cm, 3.125-mm in-plane resolution, 3-mm thick). For each participant, a high-resolution structural echo-planar imaging volume was acquired coplanar with the functional scans (TR = 5000 msec, TE = 33 msec, matrix size 128 × 128, FOV = 20 cm, 1.56-mm in-plane resolution, 3-mm thick).

fMRI Data Analysis

Using Automated Image Registration (AIR 5.0; Woods, Grafton, Holmes, Cherry, & Mazziotta, 1998; Woods, Grafton, Watson, Sicotte, & Mazziotta, 1998), all functional images for each participant were: (a) realigned to correct for head motion and coregistered to their respective high-resolution structural images using a six-parameter rigid-body transformation model; (b) spatially normalized into a Talairach-compatible MR atlas (Woods, Dapretto, Sicotte, Toga, & Mazziotta, 1999) using polynomial nonlinear warping; and (c) smoothed using a 6-mm full-width, half-maximum isotropic Gaussian kernel. Following image conversion and preprocessing, the imaging data were analyzed using Statistical Parametric Mapping (SPM99; Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK; www.fil.ion.ucl.ac.uk/spm) and MarsBaR (http://marsbar.sourceforge.net), a region-of-interest toolbox for SPM99.

For each participant, condition effects were estimated according to the general linear model, using a canonical hemodynamic response function. The resulting contrast images were entered into second-level analyses using a random effects model to allow for inferences to be made at the population level (Friston, Holmes, Price, Buchel, & Worsley, 1999). Comparisons between each condition and rest, as well as direct comparisons between conditions, were thresholded at $p < .005$ for magnitude (uncorrected for multiple comparisons) and $p < .05$ for spatial extent (corrected for multiple comparisons), except in a priori regions of interest (minimum extent = 10 voxels; Forman et al., 1995). Between-group comparisons of children and adults utilized the same thresholds as those described above. To ensure that the patterns of activity seen in the random effects analyses were not due to between-group differences in reaction times during self- and social knowledge retrieval, a difference score was created to capture the extent to which self-knowledge retrieval was easier than its social counterpart (based on differences in mean reaction time to self and social stimuli), and then these were entered as nuisance variables in an analysis of covariance (ANCOVA). All participants evidenced less than 1.5-mm mean motion during the functional run, but despite the minimal amount of movement in both groups, a significant between-group difference remained [*M*s = 0.5 and 0.2 mm for children and adults, respectively; $t(22) = 3.2$, $p < .01$]. Therefore, post hoc analyses were conducted in which parameter estimates were extracted from all regions demonstrating significant between-group differences. These parameter estimates were entered into ANCOVAs that controlled for mean motion during the entire functional run or during the subset of relevant blocks (i.e., self-knowledge retrieval blocks), and in all cases, the observed between-group differences in these regions remained significant ($p < .05$ or better).

RESULTS

Adults

Initial examination of the blood-oxygen level-dependent (BOLD) signal during self- and social knowledge retrieval epochs (in comparison to rest) indicated relatively similar patterns of activity between the two conditions (see Table 1). Common networks of neural activity included Broca's (BA 44, 45, 47) and Wernicke's (BA 21, 22) areas, primary auditory cortices (BA 41, 42), temporal pole (BA 38), motor and premotor cortices (BA 4, 6), anterior supplementary motor area (BA 6), inferior parietal lobule (BA 40), dorsomedial prefrontal cortex (DMPFC; BA 8, 9),

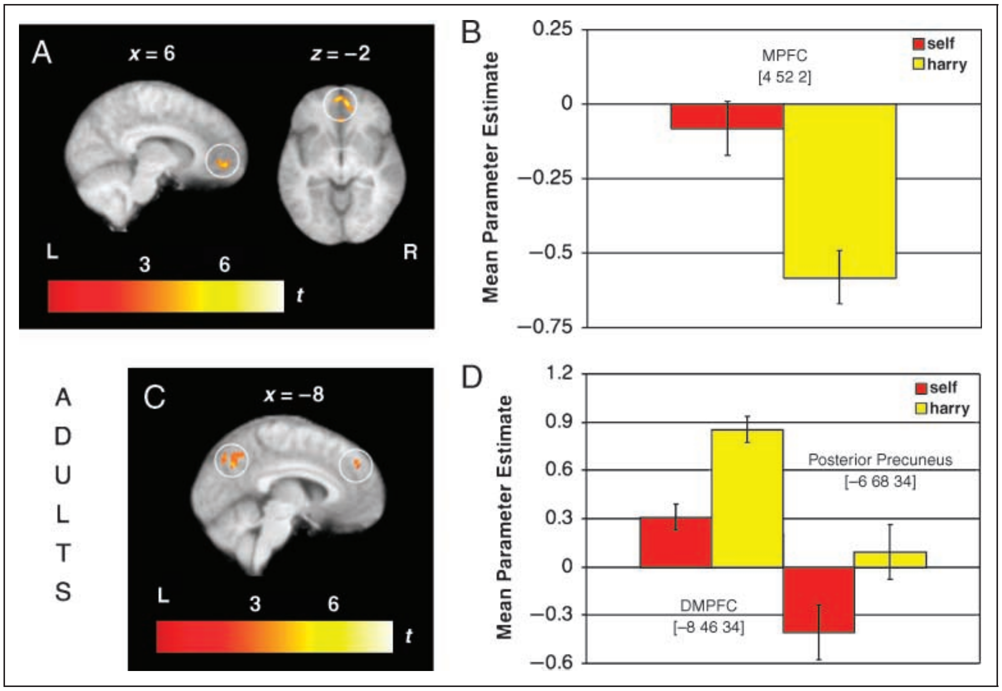
Table 1. Peaks of Activity in Adults during Self- and Social Knowledge Retrieval, Relative to Rest

			Self–Rest				*Harry Potter–Rest*			
Region	*BA*	*Hemisphere*	*x*	*y*	*z*	*t*	*x*	*y*	*z*	*t*
Lateral temporal cortex	22	L	−64	−24	2	11.74	−68	−30	6	10.04
	22	R	56	−30	8	14.31	52	−30	6	12.16
	21	L	−56	−2	−12	6.28	−62	−14	−10	5.09
	21	R	46	−26	0	9.00	58	−16	−2	10.20
Transverse temporal gyrus	41	L	−46	−30	10	5.19	−44	−24	10	5.88
	41	R	46	−32	14	6.51	42	−20	12	4.69
Inferior frontal gyrus	44	L	−46	18	22	8.05	−56	18	18	8.19
	44	R	54	20	8	3.78	54	18	12	4.55
	45	L	−56	20	8	8.60	−56	22	6	7.44
	45	R	52	20	2	5.70	52	22	2	4.91
	47	L	−48	18	−4	6.10	−44	18	2	6.96
	47	R	44	22	−4	7.63	44	18	−4	9.61
Temporal pole	38	L	−52	10	−20	7.56	−50	14	−18	5.47
	38	R	50	6	−12	6.54	50	8	−10	5.35
Dorsomedial PFC	8	L	−16	44	36	9.53	−2	40	44	5.17
	9	L	−6	52	28	3.51	−8	46	32	9.15
Medial PFC	10	L	−4	62	14	5.84	−8	58	14	5.25
	10	R	12	58	20	4.76				
Dorsolateral PFC	9	L					−56	4	38	4.05
Inferior parietal lobule	40	L	−56	−36	24	4.31	−46	−42	50	7.34
Anterior cingulate	32	R	2	22	42	10.69	0	26	38	9.12
Supplementary motor area	6	L	−4	14	50	8.35	−12	12	60	7.03
Insula		R	−36	16	6	3.85	−38	30	−2	3.80
Putamen		L	−18	8	0	5.73	−24	8	6	6.79
Caudate		R	8	4	14	7.49				
Cerebellum		R					20	−70	−30	6.57
Precentral gyrus	4	L	−40	0	48	4.79	−46	2	48	6.39
Superior frontal gyrus	6	L	−48	10	42	4.47	−42	12	50	5.15

Clusters in a priori regions of interest survive a threshold of $p < .005$ for magnitude, 10 voxels. All other clusters survive a threshold of $p < .05$ for spatial extent (corrected for multiple comparisons).

BA = putative Brodmann's area; L and R = left and right hemispheres, respectively; x, y, and z = Talairach coordinates corresponding to the left–right, anterior–posterior, and inferior–superior axes, respectively (Talairach & Tournoux, 1988); t = the highest t score within a region; PFC = prefrontal cortex.

Figure 1. Self- and social knowledge retrieval in adults. (A) This figure shows greater activity in the medial prefrontal cortex (MPFC) during self- versus social knowledge retrieval in adults. (B) Parameter estimates in the MPFC during self- and social knowledge retrieval, relative to rest. (C) This figure shows greater activity in the dorsomedial prefrontal cortex (DMPFC) and posterior precuneus during social versus self-knowledge retrieval in adults. (D) Parameter estimates in the DMPFC and posterior precuneus during self- and social knowledge retrieval, relative to rest. Images were thresholded at $p < .005$ for magnitude (uncorrected), 10 voxels.



MPFC (BA 10), anterior cingulate cortex (ACC; BA 32, 24), as well as putamen and insula. Additionally, activity in the dorsolateral prefrontal cortex (DLPFC; BA 9) and the cerebellum was detected in the social knowledge retrieval condition, and activity in the caudate was detected in the self-knowledge retrieval condition.

Direct comparisons were used to identify activity specifically related to self- or social knowledge retrieval, as opposed to that which may be attributable to basic task performance (e.g., linguistic and response processes). The MPFC was more active when retrieving knowledge about one's self versus a highly familiar other, replicating many previous studies (see Figure 1A and Table 2). Parameter estimates were extracted from the activation in BA 10 during self- and social knowledge retrieval epochs, relative to rest, using MarsBaR. Consistent with previous studies that have reported on comparisons between each condition and rest (e.g., Wicker, Ruby, Royet, & Fonlupt, 2003; Kelley et al., 2002), results indicated that in the region which significantly differed between conditions, self-knowledge retrieval did not significantly activate the MPFC relative to rest, but rather was associated with less ‘‘deactivation’’ compared to retrieving knowledge about a highly familiar other (see Figure 1B). That is, the region was less active than during rest in both self and social conditions, but significantly less so during self-knowledge retrieval, the interpretation of which is difficult as it is dependent on idiosyncratic thought processes occurring during rest. It should be noted, however, that other regions of the DMPFC and the MPFC were significantly active during each condition compared with rest, but the activity in these regions did not differ between the two experimental conditions (see Table 1).

In contrast, the DMPFC and the posterior precuneus in the MPPC were more active during social than self-knowledge retrieval (see Figure 1C and Table 2). Comparisons of parameter estimates extracted from the

Table 2. Peaks of Activity in Adults during Direct Comparisons of Self- and Social Knowledge Retrieval

			Self–Harry Potter					*Harry Potter–Self*				
Region	*BA*	*Hemisphere*	*x*	*y*	*z*	*t*	*k*	*x*	*y*	*z*	*t*	*k*
Medial PFC	10	R	4	52	−2	6.93	85					
Dorsomedial PFC	8/9	L						−8	46	36	4.43	10
Precuneus (posterior)	7	L						−6	−68	34	5.57	284

Clusters are all in a priori regions of interest and survive a threshold of $p < .005$ for magnitude, 10 voxels.

BA = putative Brodmann's area; L and R = left and right hemispheres; x, y, and z = Talairach coordinates corresponding to the left–right, anterior–posterior, and inferior–superior axes, respectively (Talairach & Tournoux, 1988); t = highest t score within a region; k = the number of voxels in a cluster; PFC = prefrontal cortex.

DPMFC and the MPPC during self- and social knowledge retrieval epochs relative to a resting baseline revealed the following (see Figure 1D). In the posterior precuneus (a region of the MPPC associated with successful episodic memory retrieval with or without imagery; Cavanna & Trimble, 2006), the difference between the two conditions was due to significantly less activation during self-knowledge retrieval than rest, as opposed to an increase during social knowledge retrieval. However, the difference between the two conditions in the DMPFC was due to greater activation during social knowledge retrieval than self-knowledge retrieval, although in both conditions this region was significantly more active than during rest. Post hoc whole-brain analyses conducted at stricter thresholds revealed no additional activations during either of these direct comparisons.

Children

In children, initial examination of activity during self- and social knowledge retrieval (relative to rest) produced patterns generally similar to those seen in adults (see Table 3). Common networks of neural activity included Broca's (BA 44, 45, 47) and Wernicke's (BA 21, 22) areas, primary auditory cortices (BA 41, 42), temporal pole (BA 38), anterior supplementary motor area (BA 6), DMPFC (BA 8, 9), ACC (BA 32, 24), as well as putamen and insula. Additionally, in the self-knowledge retrieval condition, activity in the MPFC (BA 10) and the caudate was detected. At lower thresholds for spatial extent, activity in motor and premotor cortices (BA 4, 6) and inferior parietal lobule was observable in both conditions, similar to that seen in adults.

Direct comparisons were then used to identify activity specifically related to self- or social knowledge retrieval, which suggested both similarities and differences between adults and children. Like in adults, the MPFC was more active when retrieving knowledge about one's self versus a highly familiar other (see Figure 2A and Table 4). Parameter estimates were extracted from the activation in BA 10 during self- and social knowledge retrieval epochs, relative to rest, using MarsBaR. The

Table 3. Peaks of Activity in Children during Self- and Social Knowledge Retrieval, Relative to Rest

			Self–Rest				*Harry Potter–Rest*			
Region	*BA*	*Hemisphere*	*x*	*y*	*z*	*t*	*x*	*y*	*z*	*t*
Lateral temporal cortex	22	L	−66	−22	0	5.85	−60	−22	6	8.58
	22	R	52	−24	2	8.24	48	−22	2	10.13
	21	L	−58	−14	−12	6.33	−62	−10	−16	7.28
	21	R	54	−28	2	7.35	54	−20	2	9.77
Inferior frontal gyrus	44	L	−54	18	8	5.80	−54	22	16	4.24
	45	L	−54	22	0	9.28	−56	22	6	6.92
	47	L	−56	14	0	6.54	−52	20	−2	7.35
	47	R	44	14	−2	5.87				
Temporal pole	38	L	−50	18	−8	6.48	−46	14	−12	3.95
Dorsomedial PFC	8	L	−8	40	38	5.76	−6	26	46	5.70
	9	L	−12	42	28	5.88				
Medial PFC	10	L	−10	52	16	4.28				
	10	R	2	58	14	4.72				
Dorsolateral PFC	9	L	−42	4	42	7.79				
Anterior cingulate	32	L	−2	28	34	5.84	−2	22	40	5.29
Supplementary motor area	6	L	−6	8	56	6.97	−12	10	62	5.98
Insula		R	34	18	0	4.56	46	14	−2	4.40
Putamen		R	14	14	6	3.45	28	18	6	6.29
Caudate		R	10	−4	18	7.57				

Clusters in a priori regions of interest survive a threshold of $p < .005$ for magnitude, 10 voxels. All other clusters survive a threshold of $p < .05$ for spatial extent (corrected for multiple comparisons).

BA = putative Brodmann's area; L and R = left and right hemispheres; x, y, and z = Talairach coordinates corresponding to the left–right, anterior–posterior, and inferior–superior axes, respectively (Talairach & Tournoux, 1988); t = the highest t score within a region; PFC = prefrontal cortex.

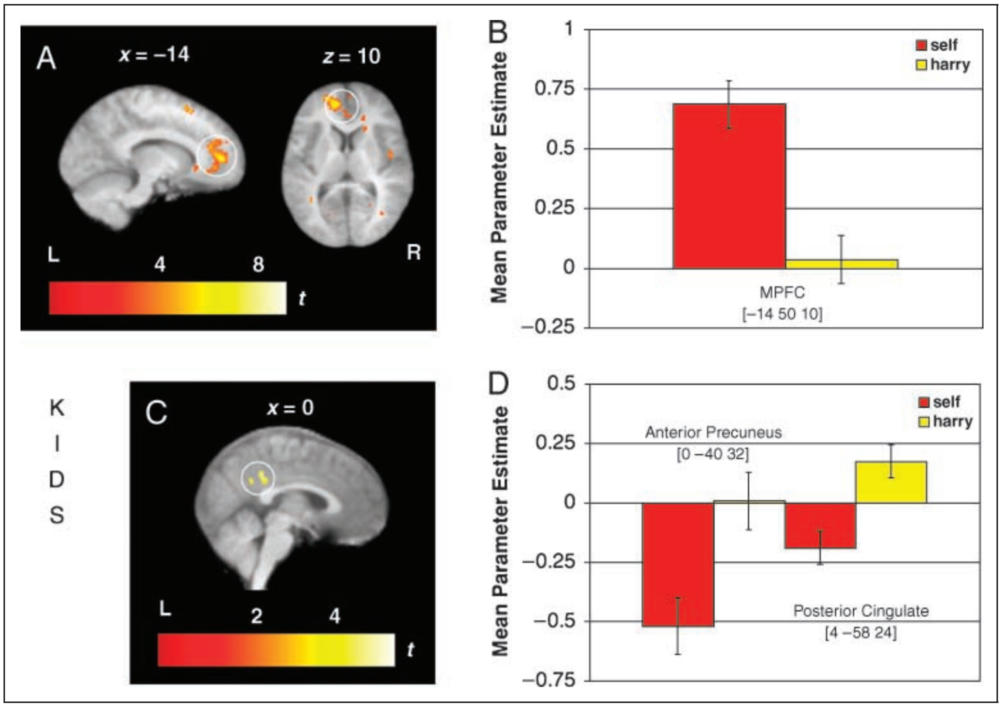


Figure 2. Self- and social knowledge retrieval in children. (A) This figure shows greater activity in the medial prefrontal cortex (MPFC) and the anterior cingulate cortex (ACC) during self- versus social knowledge retrieval in children. (B) Parameter estimates in the MPFC during self- and social knowledge retrieval, relative to rest. (C) Greater activity is seen in the anterior precuneus and the posterior cingulate during social versus self-knowledge retrieval in children. (D) Parameter estimates in the anterior precuneus and the posterior cingulate during self- and social knowledge retrieval, relative to rest. Images were thresholded at $p < .005$ for magnitude (uncorrected), 10 voxels.

pattern that emerged was notably different from adults, in that self-knowledge retrieval produced true activations in the MPFC relative to rest (see Figure 2B). The reverse comparison again suggested similarities and differences between adults and children, in that only the anterior precuneus and the posterior cingulate in the MPPC were relatively more active during social than self-knowledge retrieval (see Figure 2C and Table 4). Comparisons of parameter estimates extracted from the MPPC during self- and social knowledge retrieval epochs relative to rest revealed a slightly more complex pattern (see Figure 2D). In the anterior precuneus (a region of the MPPC associated with self-guided mental imagery; Cavanna & Trimble, 2006), the difference between the two conditions was due primarily to significantly less activation during self-knowledge retrieval than rest, as opposed to an increase during social knowledge retrieval. However, the difference between the two conditions in the posterior cingulate resulted from a combination of more activation during social knowledge retrieval, and less activation during self-knowledge retrieval, relative to rest.

Post hoc whole-brain analyses conducted at stricter thresholds revealed only one additional activation dur-

Table 4. Peaks of Activity in Children during Direct Comparisons of Self- and Social Knowledge Retrieval

			Self–Harry Potter					*Harry Potter–Self*				
Region	*BA*	*Hemisphere*	*x*	*y*	*z*	*t*	*k*	*x*	*y*	*z*	*t*	*k*
Medial PFC	10	R	4	58	14	4.22	32					
	10	R	8	56	6	4.09	18					
	10	L	−24	56	12	8.10	943*					
	10	L	−14	48	10	6.25	943*					
Anterior cingulate	24/32		−2	36	4	7.59	943*					
Precuneus (anterior)	7							0	−40	32	3.96	31
Posterior cingulate	31							4	−58	24	4.56	25

Clusters are all in a priori regions of interest and survive a threshold of $p < .005$ for magnitude, 10 voxels.

BA = putative Brodmann's area; L and R = left and right hemispheres; x, y, and z = Talairach coordinates corresponding to the left–right, anterior–posterior, and inferior–superior axes, respectively (Talairach & Tournoux, 1988); t = the highest t score within a region; k = the number of voxels in a cluster; * = local maxima within large clusters; PFC = prefrontal cortex.

ing self-knowledge retrieval, relative to social knowledge retrieval: ACC (see Table 4). No additional activations were observed at this level during social knowledge retrieval, compared to self-knowledge retrieval. Interestingly, the DMPFC (which was more active in adults during social than self-knowledge retrieval) was not significantly more active in children during social than self-knowledge retrieval. Comparisons of parameter estimates extracted from the region of the DMPFC that was more active in adults during social than self-knowledge retrieval (BA 8/9 [−8 46 36]) indicated no significant difference, although the pattern of means suggested that children may even recruit this region more for self- than social knowledge retrieval (*M*s = 0.98 and 0.30, *SD*s = 0.33 and 0.42, respectively).

Comparison between Children and Adults

The final set of analyses compared patterns of neural activity during self- and social knowledge retrieval between children and adults. The results demonstrated that the MPFC (BA 9, $t = 4.7$ [−16 54 24] and BA 10, $t = 3.7$ [−10 54 14]) and the ACC (BA 32, $t = 4.1$ [−12 42 2]) were significantly more active in children than in adults during self-knowledge retrieval, in comparison to social knowledge retrieval (see Figure 3), and so was the posterior precuneus (BA 7, $t = 3.0$ [−6 −68 34]). In contrast, the anterior precuneus (BA 7, $t = 3.7$ [−8 −30 46]) was significantly more active in adults than in children during self-knowledge retrieval, as compared to social knowledge retrieval. This interaction can be simplified by returning to the main effects for self- and social knowledge retrieval epochs relative to rest, initially described separately in adults and children. These main effects provide confirmation that the findings in the MPFC and the ACC were due to greater activation during self-knowledge retrieval in children than in adults (as compared to rest), but suggest that the posterior precuneus activation likely resulted from relatively less activity in this region during self-knowledge retrieval in adults as compared with rest. Similarly, the finding that the anterior precuneus was more active in adults than in children during self-knowledge as compared with social knowledge retrieval appears to result from relatively less activity in this region during self-knowledge retrieval in children as compared with rest (see Figures 1 and 2 for illustrative parameter estimates from these regions).

Analyses of reaction time data collected during the task indicated that there was no significant difference in average response latencies per condition in children (*M*s = 2.3 and 2.3 sec, *SD*s = 0.2 and 0.3 sec, for self- and social knowledge retrieval, respectively), but that adults were significantly faster at self- than social knowledge retrieval [*M*s = 2.1 and 2.2 sec, *SD*s = 0.1 and 0.1 sec, for self- and social knowledge retrieval, respectively; $t(22) = -3.9$, $p < .005$], and also significantly faster at self-knowledge retrieval than children [$t(22) = 4.3$, $p < .001$]. Therefore, we sought to rule out the possibility that between-group differences in reaction time during self- and social knowledge retrieval contributed to the patterns seen in the direct comparisons between the two conditions by covarying out differences in reaction time between conditions and then conducting direct comparisons between self- and social knowledge retrieval using the same thresholds. The results described above remained: The MPFC and the ACC were more active in children than in adults during self-knowledge retrieval relative to rest, and the anterior and posterior precuneus were relatively less active during self- than social knowledge retrieval.

Because children activated the MPFC much more strongly than adults, this suggested the possibility that adults utilized other regions (and/or neurocognitive processes) to accomplish the retrieval task. We hypothesized that adults were relying less on active self-reflection and more on stored self-knowledge during the task; to test this hypothesis, we directly compared patterns of activity seen in children and adults during self-knowledge retrieval relative to rest. Consistent with the notion that adults rely more on stored self-knowledge than children, adults activated the lateral temporal cortex (LTC, a region associated with semantic memory retrieval; Cabeza

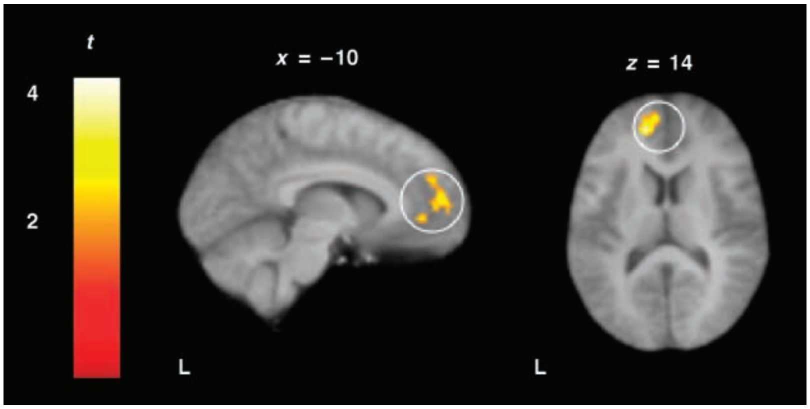


Figure 3. Comparisons between children and adults. The medial prefrontal cortex (MPFC; BA 9 and 10) and the anterior cingulate cortex (ACC; BA 32) were relatively more active in children than in adults during self- versus social knowledge retrieval. Images were thresholded at $p < .005$ for magnitude (uncorrected), $p < .05$ for spatial extent (corrected).

& Nyberg, 2000) significantly more than children (BA 22, $t = 3.8$ [−66 −34 4]). The LTC was one of only two regions in the brain (the other being the angular gyrus [BA 39], $t = 4.4$ [36 −64 18]) that was significantly more active in adults than in children during self-knowledge retrieval. As might be expected from the previous comparisons, children activated the MPFC (BA 10, $t = 3.3$ [−18 46 10]) and the ACC (BA 32 and 24, $t = 3.9$ [4 18 32]) significantly more than adults during self-knowledge retrieval relative to rest, as well as the insula ($t = 4.2$ [40 12 −2]).

DISCUSSION

The primary purpose of this study was to identify the neural correlates of self- and social knowledge retrieval in children, as well as to directly compare the systems involved in these processes in children and adults. As predicted, the MPFC and the MPPC were implicated in self- and social knowledge retrieval, but there were significant differences in the pattern of activation in these regions for children and adults. The major similarity seen between children in this study and adults from this and other studies in the neural basis of self-knowledge retrieval was that similar cortical midline structures were implicated in these processes, namely, the MPFC and the MPPC. However, the patterns of relative activation in the MPFC and the MPPC during self- and social knowledge retrieval (as compared to a resting baseline) significantly differed between children and adults.

Medial Prefrontal Cortex

First, there was clear evidence of increased BOLD signal in the MPFC during children's self-knowledge retrieval, relative to both social knowledge retrieval and a resting baseline. Although relatively greater activity in the MPFC during self-knowledge retrieval is often seen in adults when compared to other knowledge retrieval tasks, increases relative to baseline have not typically been reported in these studies. Several studies have specifically demonstrated that the activations in the MPFC are a result of less ''deactivation'' during self-knowledge retrieval than comparison tasks (that is, the region was less active than during rest in both conditions; e.g., Wicker et al., 2003; Kelley et al., 2002). A similar pattern was also observed in the adults in this study, suggesting that the task was comparable to those previously used in adults and successfully tapped neural processes supporting self-knowledge retrieval. Because regions in the MPFC have been associated with self-reflection and mentalizing (about oneself and others; e.g., D'Argembeau et al., 2005; Frith & Frith, 2003), one possible interpretation of the activation pattern seen in the MPFC is that it reflects less frequent self-reflective activity of the MPFC during rest in children. In other words, it is possible that developmental differences in mental activity during rest contributed to the observed results.

The MPFC activity seen during self-knowledge retrieval in children was not only greater in magnitude than that seen during a resting baseline but also covered a large spatial extent at relatively strict thresholds for magnitude, compared to social knowledge retrieval. This is consistent with previous developmental cognitive neuroscience studies that have suggested activity in regions central to task performance shifts from diffuse to focal patterns with development, whereas activity in noncentral regions diminishes in magnitude (e.g., Durston et al., 2006; Casey, Giedd, & Thomas, 2000; for a review, see Casey, Galvan, & Hare, 2005). It is thought that functional and structural development of these regions, as well as their interconnections with other brain regions, leads to greater neural efficiency (resulting in decreases in magnitude and/or spatial extent with development). In general, the prefrontal cortex and its interconnections are known to undergo structural changes during childhood and adolescence (for reviews, see Casey et al., 2005; Sowell, Thompson, & Toga, 2004). Thus, an alternative interpretation of the activation pattern in the MPFC is that children's self-knowledge retrieval utilizes more neural resources in task-central regions—whether due to functional inefficiency in and of itself, and/or because the task requires greater mental effort for children to complete successfully. Interestingly, however, although we did find that adults were significantly faster at self-knowledge retrieval than children as predicted, covarying out reaction time differences did not account for the differences in MPFC activation between children and adults. This suggests that effort, at least as quantified by reaction times, is insufficient to explain the patterns we observed, and perhaps general age-related differences in brain function and organization are more significant contributing factors. Future studies should explore the role of these general age-related effects, which may include structural development, for example, by examining the correlation between cortical thickness and functional activation of the MPFC.

More speculatively, the increased magnitude and spatial extent of activity in MPFC activity seen in children may also result specifically from the lack of automaticity in children's self-knowledge retrieval processes, causing an overreliance solely on this region to the neglect of others. Previous research in adults has demonstrated that self-knowledge retrieval in high-experience, high-identification domains is more automatic, supported by structures such as the amygdala, the nucleus accumbens, the LTC, and the ventromedial PFC (BA 11; Lieberman et al., 2004). Because the majority of research examining the neural basis of self-knowledge retrieval in adults has not assessed domain-specific effects, the additional processing resources provided by these structures is unaccounted for. Thus, the increase in MPFC activity relative to a resting baseline in children may be conceived of as a consequence of the greater processing demands placed on this region relative to those in adults (for whom neural activity is likely to be distributed among several additional regions, including the LTC observed in this investigation). Such a pattern was recently observed in a study examining the neural correlates of irony comprehension, which involves reasoning about a speaker's communicative intent, and therefore, overlaps with theory of mind processes (Wang et al., 2006). Despite using kid-friendly cartoon scenarios and finding no differences in accuracy or reaction times between children and adults, significant MPFC activity was observed only in children; moreover, a strong negative correlation between age and MPFC activity was also seen in children, suggesting that the MPFC may become less necessary for successful performance on mentalizing tasks as a function of development. In contrast to the children, adults activated the left LTC (as well as right posterior occipito-temporal regions) more than children, similar to our study.

Medial Posterior Parietal Cortex

The results in the MPPC during self- and social knowledge retrieval were more complex. In both children and adults, although it appeared that the precuneus was more active during social than self-knowledge retrieval for both groups, examination of each condition relative to rest indicated that this resulted from significantly less activation of this region during self-knowledge retrieval than rest (however, there was significantly more activation in the posterior cingulate during social knowledge retrieval than rest). In previous studies, adults frequently demonstrated relatively greater activity in the MPPC during self-knowledge retrieval (e.g., Johnson et al., 2002; Kelley et al., 2002), although again this has never been depicted as an increase relative to rest. Therefore, the absence of such a pattern in this study may have resulted from task differences according to the following logic. Although the other social target (Harry Potter) is actually a fictional character, he is one about whom all participants had several significant sources of information, including books and movies rich with details. This store of information is arguably more extensive, concrete, and visualizable than that which most children—and perhaps many adults—would be expected to have about other social targets commonly used in similar neuroimaging studies (e.g., the president). Because the precuneus and the posterior cingulate in the MPPC have been associated with episodic memory retrieval and linking new information with prior knowledge (e.g., Cavanna & Trimble, 2006; Cabeza & Nyberg, 2000; Maguire et al., 1999), and activity in the MPPC has also been associated with third-person perspective-taking (e.g., Ruby & Decety, 2004), perhaps the nature of the information participants had about Harry Potter enabled more of these processes than is usually the case with other social targets.

There was also a notable difference between the results of children and adults in the MPPC. Specifically, in adults, the posterior precuneus was relatively more active during social than self-knowledge retrieval, whereas in children, the anterior precuneus and the posterior cingulate were relatively more active during social than self-knowledge retrieval. A recent review of the precuneus dissociated the posterior precuneus, which is involved in successful episodic memory retrieval regardless of the use of imagery, and the anterior precuneus, which is involved in self-centered mental imagery strategies and perspective-taking (Cavanna & Trimble, 2006). Perhaps children used significantly more imagery and perspective-taking when reporting about characteristics of Harry Potter than adults, leading to the use of more anterior regions of the precuneus. This pattern may reflect more advanced social (rather than introspective) perspective-taking abilities in children, which is consistent with behavioral research, suggesting that social comparison and perspective-taking skills facilitate self-concept development, rather than the reverse (Harter, 1999; Frey & Ruble, 1990; Damon & Hart, 1988). The dissociation in the MPPC between children and adults additionally suggests that perhaps adults think about other people in more abstract, less image-dependent ways than children.

Dorsomedial Prefrontal Cortex

Our introduction contrasted the viewpoint of symbolic interactionists, who theorized that the self is essentially grounded in social knowledge (Mead, 1934; Cooley, 1902; Baldwin, 1895), with that of some neuroscientists who have suggested that the neural correlates of self-knowledge retrieval processes may be unique from other types of social or semantic retrieval tasks (D'Argembeau et al., 2005; Lieberman et al., 2004; Johnson et al., 2002; Kelley et al., 2002; Fink et al., 1996). We found that the DMPFC, which has been associated with thinking about other individuals' mental states—particularly those who are not seen as similar to oneself (Mitchell et al., 2005, 2006; Mitchell, Macrae, & Banaji, 2004)—was predictably more active in adults during social than self-knowledge retrieval. In contrast, children did not rely more on the DMPFC to reason about another individual than about themselves—they instead appeared to recruit this region for both tasks, with a trend toward even greater recruitment of the DMPFC for self- than social knowledge retrieval. One interpretation of this pattern is that perhaps children do scaffold from social sources of knowledge to understand themselves, thus utilizing the DMPFC to a greater extent. In other words, perhaps as self-knowledge becomes an important goal in preadolescence, children draw inferences about themselves in much the same way that they make sense of other people. This suggests two further developmental hypotheses: First, that only later in development would the DMPFC be devoted more specifically to social cognition and less to self-reflection and second, that the DMPFC may be relied upon even more heavily for self-knowledge retrieval at younger ages than studied here.

Limitations

A limitation of our interpretation of the results both between conditions and between groups in frontal brain regions (including the MPFC and the ACC) is the possibility of differences in emotional responsivity to the phrases when applied to oneself, rather than another social target. Frequently, more ventral regions of the MPFC (e.g., BA 11, ventromedial and orbito-frontal PFC) have been associated with representing the affective meaning of stimuli, whereas more dorsal regions (e.g., BA 8 and 9, DMPFC) have been affiliated with cognitive monitoring of mental states (Britton et al., 2006; Simmons, Stein, Matthews, Feinstein, & Paulus, 2006; Mitchell et al., 2004; Adolphs, 2003; Gusnard, Akbudak, Shulman, & Raichle, 2001), suggesting that emotion may not be the only explanation of our findings, as the primary effects were not in ventral regions. However, this dissociation is still being investigated, and has never even been explicitly explored in children. Furthermore, there is some evidence suggesting that the ACC, in particular (which was significantly more active during self- than social knowledge retrieval in children), is affiliated with emotional responding in children (e.g., to emotional faces; McClure et al., 2004; Nelson et al., 2003). Finally, a recent study has also shown that merely judging the valence of traits can also activate the MPFC (BA 10; Ochsner et al., 2005), but the possibility of an association between self-descriptiveness and positivity of traits was not investigated and may have confounded their results. Future research should focus on disentangling the specific contributions of self-relevance and affect with respect to increased activity in the MPFC and the ACC during self-knowledge retrieval.

Conclusion

Future longitudinal fMRI studies of self-development during adolescence are needed to examine how neurocognitive processes of self-knowledge retrieval change over time to approach those of adults. Younger and older age groups should be sampled to more fully examine these developmental differences, as young children are thought to use qualitatively different mental strategies than do adults to report on themselves, whereas adolescents are known to have a heightened sense of self-awareness (Vartanian, 2000; Elkind, 1967; Hall, 1904). Furthermore, self-concepts are known to be powerful predictors of adolescent adjustment and achievement (for example, children who think positively of their social abilities tend to have greater social support and experience less loneliness; Harter, 1999), and thus, further work should also focus on developmental trajectories of self-knowledge retrieval processes in specific domains. Specifically, previous research has suggested that for domains in which one is highly experienced and identifies with personally, self-knowledge retrieval proceeds on a more intuitive basis—supported by neural structures associated with automatic, affective processes (Lieberman et al., 2004). Perhaps as self-concepts solidify during childhood and adolescence, individuals transition from evidentiary-based processes of self-knowledge retrieval (supported by the MPFC and/or the MPPC) to intuition-based processes. This developmental model has yet to be tested.

The similarities and differences seen between children and adults in the neural bases of self- and social knowledge retrieval present several implications for social cognitive development. First, the activation of the MPFC relative to rest suggests that, on average, 9- and 10-year-old children may be engaged in significantly less introspective or self-reflective thought than adults in the absence of specific task demands, as discussed above. Therefore, when children were instructed to retrieve self-knowledge, the activation was more intense by comparison. The activation was also greater in spatial extent, which replicates a pattern seen previously in studies of the development of inhibitory control: As expertise develops, it is associated with more focal patterns of neural activity (e.g., Casey et al., 2005). Further research with children and adolescents comparing self- and social knowledge retrieval to other retrieval tasks may prove particularly interesting due to the dramatic changes in motivation and orientation toward oneself and others during childhood and adolescence (Vartanian, 2000; Damon & Hart, 1988). That is, patterns of activity in the MPFC might drastically change as children transition into chronically self-reflective adolescents. Second, the relatively greater activation during social than self-knowledge retrieval of the posterior precuneus in adults, but the anterior precuneus and the posterior cingulate in children, suggests a distinction heretofore unexamined in developmental research: Children's social perspective-taking may be based more heavily on imagery than that of adults. Future developmental studies may predict that as children age, they will become less likely to use imagery in service of social perspective-taking, and thus, the pattern of neural activity might shift to more posterior aspects of the MPPC when retrieving knowledge about social targets.

The results of this study also suggest—more strongly than any previous neuroimaging studies of self-knowledge retrieval—that the MPFC is involved in self-reflection processes, and not as a storage site for self-knowledge. In adults, the relatively lesser involvement of the MPFC and the greater involvement of the LTC during self-knowledge retrieval imply that on-line self-reflective work may be diminished compared with children when reporting about the attributes of oneself, and long-term knowledge stores may facilitate ''expert'' self-processing. If the MPFC was primarily a self-knowledge storehouse rather than a site for active self-processing, the MPFC should have been more active in adults than children, as adults have a much greater base of self-knowledge. This was not the case, and instead, the LTC was more active in adults than children. Not only has the LTC previously been associated with semantic memory retrieval in general (Cabeza & Nyberg, 2000), but in a previous study of self-knowledge retrieval, greater activation of this region was seen during retrieval from a high-experience domain, relative to a low-experience one (Lieberman et al., 2004). In children, however, greater involvement of the MPFC and relatively less activation of semantic knowledge stores in the LTC imply active construction of self-descriptive attributes in response to the task at hand.

Finally, the current examination of the relationship between self- and social knowledge retrieval during development may help refocus the ongoing neuropsychological debate about whether the self is indeed ''special.'' Perhaps the question should no longer be ''is the self special,'' but rather, what are the component processes (e.g., self-knowledge, self-reflection) that constitute the self, how and when do they contribute to our development and experience of an integrated sense of self, and what neural resources support these abilities? Such queries would provide a better foundation for understanding the neural underpinnings of typical self-development, and ultimately, atypical trajectories as well (e.g., as experienced by maltreated children or those suffering from other forms of psychopathology; Nelson, Leibenluft, McClure, & Pine, 2005; Rogosch & Cicchetti, 2005).

SUPPLEMENTARY ONLINE INFORMATION

The following stimuli were used in this study (see Methods for more details):

I am popular
I have many friends
I get invited to lots of parties
I always dress cool
I make friends easily
I never eat lunch by myself
I'm never lonely at school
Popular kids like me
I don't get teased at school
My friends are popular
I wish I had more friends
Other kids ignore me
Nobody wants to talk to me
I get left out at school
I often eat lunch by myself
I feel lonely at school
I often get teased at school
Kids don't want to be around me
Nobody wants to be my friend
My friends are unpopular
I like to read more than others
I like going to the library
Teachers think my writing is good
Book reports are easy for me
Crossword puzzles are fun
I read very quickly
I do not make spelling mistakes
I am a good speller
I like to read just for fun
I like to write stories
I don't like writing assignments
I only read if I have to
I like to read less than others
Writing is so boring
Teachers think my grammar is bad
It's hard for me to write papers
Books are boring
My essays are really messy
I am a bad speller
I make many spelling mistakes

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Reprint requests should be sent to Jennifer H. Pfeifer, UCLA Department of Psychology, 1285 Franz Hall, Los Angeles, CA 90095-1563, or via e-mail: jenn.pfeifer@gmail.com.

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