COMMENTARY

SELF-AWARENESS AND THE LEFT HEMISPHERE: THE DARK SIDE OF SELECTIVELY REVIEWING THE LITERATURE

Alain Morin

(Behavioral Sciences, Mount Royal College, Calgary, Alberta, Canada)

For seven years now Keenan and his colleagues have been proposing the notion of right hemispheric dominance for self-awareness (e.g., Feinberg and Keenan, 2006; Johnson et al., 2005; Keenan et al., 2000, 2001, 2003; Lou et al., 2004; Platek et al., 2004a). Concerns about this view were raised on two occasions (Morin, 2002, 2003) and were modestly acknowledged by the team in Platek et al. (2004b). In the target article, Keenan et al. (2005) present their latest version of the hypothesis, which in my view carries over the exact same problems identified in the past. In this commentary I examine conceptual and empirical difficulties pertaining to the notion of right hemispheric superiority for self-related processes. I will suggest that two main misconceptions lie at the heart of the controversy. (1) At a conceptual level, one cannot equate either self-recognition or Theory-of-Mind (TOM) abilities with genuine self-awareness. (2) At an empirical level, the review of literature presented by Keenan et al. tends to favor studies that support their hypothesis. In actuality, quite a few brain-imaging experiments show bilateral and left hemisphere activity during self and other judgment tasks.

Self-recognition and self-awareness

"Self-awareness involves being aware of one's own thoughts, or mental state. It includes having the ability to reflect on one's own cognitions. Further, self-awareness includes the ability to think about oneself as an entity in the third person, allowing for imagining oneself in the future or in the past" (p. 695). After presenting Gallup's work on self-recognition in primates (e.g., Gallup, 1970; Gallup et al., 2002), and related research, Keenan et al. ask: "Does self-recognition equal self-awareness?" (p. 696). Their answer is a confident "yes", which lead them to suggest that "... the self-face may be an ideal stimulus to begin the investigations of higher-order consciousness and the brain" (p. 697). The group then reviews several studies that have examined selective brain activation during self-face recognition tasks as well as other forms of self-recognition (e.g., one's voice), and neuropsychological reports of right hemisphere damage. The body of research presented in Keenan et al.'s paper largely supports right hemisphere superiority for self-recognition, which motivates the conclusion that "... along numerous dimensions, the right hemisphere appears dominant for self-awareness" (p. 700).

The overall rationale put forward by Keenan and his collaborators is simple and elegant: (1) self-recognition equals self-awareness; (2) self-recognition is correlated with activity in the right hemisphere, especially the prefrontal lobe; (3) thus, self-awareness *per se* is also linked to right hemisphere activity. I hope to show that the first two statements (1) and (2) are most likely inaccurate, which obviously will make statement (3) incorrect.

The proposition that self-recognition is equivalent to self-awareness, as defined in the target article, has been extensively – and convincingly – criticized by Mitchell (e.g., 1993; 2002a, 2002b). Gallup's original view (1970), implicitly endorsed by Keenan et al., is that emitting self-directed responses in front of a mirror (such as touching one's forehead during the "dye [or mirror] test") indicates that the organism can become the object of its own attention; in addition, *re*-cognizing oneself in front of a mirror presupposes "self-cognition" (self-knowledge, a self-concept) – and thus self-awareness. Certainly, self-recognition involves self-attention and self-knowledge; but Mitchell's key question is: What type of self-information is required for recognition of one's face (and body)? He argues that all an organism needs to self-recognize is a kinesthetic representation of its own *body*; the organism matches the mental representation of the physical self with the reflection seen in the mirror and concludes that "it's me." In that perspective, access to one's own *thoughts* (or any other more "private" aspects of the self) is not necessary for self-recognition to occur. Indeed, one may inquire: In what way can knowing about one's own political opinions (or current emotions, goals, values, thinking patterns, etc.) help an organism to correctly identify the reflection in a mirror as being oneself? Again, awareness of thought processes do not seem to be pertinent for self-recognition; however, awareness of the body is crucial for self-

identification in front of a mirror. This implies that while self-recognition entails kinesthetic self-knowledge, it does not require mental/cognitive self-knowledge. So, to state that self-recognition represents a adequate operationalization of self-awareness, defined as "being aware of one's own thoughts, or mental state" (p. 695), is misleading.

But then there is this work conducted by Lewis (e.g., 1992) that "... correlated self-awareness with passing the mirror test. For example, he has found that only children that pass the mirror test exhibit self-conscious emotions (i.e., emotions that require a sense of self) such as shame, guilt, and pride. In children that do not pass the test, such emotions are not exhibited" (target article, p. 696). "It has also been found that personal pronouns such as "I" and "me" are correlated with the timeline of self-recognition" (p. 696). Furthermore, one's understanding of others' mental states (TOM) seems related to one's insight into one's own mind. The key term here, obviously, is "correlated". The seemingly simultaneous development of self-recognition, self-conscious emotions, first-person pronouns use, and TOM in humans hardly means that the former *causes* the latter. It remains plausible that these four abilities emerge in concert because of the parallel growth of other, more fundamental, underlying variables – language and/or social skills would represent strong potential candidates (see Astington and Jenkins, 1999; Garfield et al., 2001; Nelson, 2005). Also note that (1) TOM in children develops much later than self-recognition – between ages three and five (Saxe, 2006), as opposed to between months 18 and 24 for self-recognition (Amsterdam, 1972); (2) in most non-human primates self-recognition is observed in the *absence* of self-conscious emotions and use of personal pronouns; and (3) in one study (Cunningham and Glenn, 2004) 96% of young adults with Down syndrome demonstrated self-recognition from their photograph while only 57% showed awareness of their disability – a clear indication that self-recognition does not automatically entail knowledge of fundamental self-aspects. The relation between self-recognition and TOM in apes is more ambiguous, as Keenan et al. themselves confess (p. 696). While Gallup (e.g., 1998) firmly believes that there is a link, some question its existence (e.g., Povinelli, 1995) and others even reject the idea of TOM in primates (e.g., Heyes, 1998).

Not only is statement (1) uncertain (self-recognition equals self-awareness) – proposition (2), suggesting that self-recognition selectively recruits right prefrontal areas, has been intensely debated in the literature. As seen earlier, there is no doubt that a wide collection of studies show a right hemisphere activation bias during self-face recognition. However, some other studies report *bilateral* activation, or plain *left* hemisphere superiority for self-recognition. To illustrate, Kircher et al. (2001—briefly mentioned in the target article) observed that "recognition of the own face activated right limbic and left prefrontal regions…"; "the left prefrontal cortex… was only activated by self-faces…" (pp. B10-B11). Sugiura et al. (2005) noted that activation selective to one's own face was observed in the right occipito-temporo-parietal junction and frontal operculum, and in the left fusiform gyrus. Turk et al. (2002) found a clear left hemisphere bias for self-recognition in a split-brain patient (also see Brady et al., 2004). And in another split-brain study (Uddin et al., 2005), both left and right hemispheres were equally capable of self-recognition (also see Sperry et al., 1979). This is only a sample, and it suggests that trying to locate self-recognition exclusively in the right hemisphere might be premature.

In summary, it is doubtful that self-recognition involves self-awareness of an introspective type; therefore, even if self-recognition is linked to right hemisphere activity (and, as seen above, this is debatable), it doesn't follows that self-awareness itself also represents the result of that same lateralized activity.

Theory-of-Mind and Self-awareness

"Theory of Mind can be referred to as mental state attribution or mindreading. Theory of Mind involves the recognition that other minds are possible, and the individual may be privy to thoughts of another" (target article, p. 695). Here too, the logic used by Keenan's group is straightforward and very similar to the one that applies to self-recognition: (1) TOM equals (or at least, is strongly related to) self-awareness; (2) TOM mostly involves right hemisphere activity (again, the prefrontal lobe); (3) consequently, self-awareness per se also depends on right hemisphere activity. I will suggest that the first two propositions (1) and (2) require serious qualifications, which will render statement (3) improbable.

That TOM and self-awareness are interconnected makes no doubt. The argument provided by Keenan et al. (known as the "simulation view" – see Hesslow, 2002) is largely accepted in the literature (but see Saxe, 2005). It is very likely indeed that one needs first to access one's own mental self before one can ponder about others' potentially comparable inner life. The team's work on deception (which requires effective reading of others' mind) and self-awareness also offers supplementary support. In addition to evidence presented in the target paper to corroborate the link between self-awareness and TOM, there is a growing number of neuroimaging experiments that show a definite overlap ('shared representations') between self and other processes in the brain, particularly in the medial prefrontal cortex (e.g.,

Abu-Akel, 2003; Amodio and Frith, 2006; Decety and Sommerville, 2003; Decety and Grèzes, 2006; Jackson et al., 2006; Mitchell et al., 2005).

"However, sharedness does not mean identicality...", as Decety and Sommerville put it (2003, p. 527), which signifies that although self-awareness and TOM are connected, they are not identical. For one thing, by definition, TOM implies a focus of attention on *others* – not the self, whereas self-awareness exclusively entails *self*-focus. These two processes thus cannot be equated (Morin, 2003). Also note that self-awareness does not represent a uniform construct and is actually made up of two different tendencies: self-reflection and self-rumination (Trapnell and Campbell, 1999). Self-reflection constitutes a authentic curiosity about the self, where the individual is intrigued and interested in learning more about his or her emotions, values, thought processes, goals, attitudes, etc. Self-rumination refers to anxious attention paid to the self, where the person fears failure and keeps wondering about his or her self-worth. Only self-reflection has been shown to lead to TOM (i.e., empathy); self-rumination actually inhibits TOM because the person is too self-absorbed to think about others' mental states (Joireman et al., 2002; Joireman, 2004).

At any rate, the claim that "there is good evidence that tasks requiring Theory of Mind engage the right hemisphere" (p. 701) is problematic. Some studies do show greater activation of the right prefrontal cortex during TOM tasks (e.g., Vogeley et al., 2001 – cited in the target article), but quite a few other experiments also implicate the *medial* prefrontal cortex (as seen above), as well as areas of the *left* hemisphere (especially the left medial frontal gyrus). To illustrate, Harris et al. (2005) reported activation of the right superior temporal sulcus and left medial prefrontal cortex in participants attributing behavior to characteristics of a person. Calarge et al. (2003) asked volunteers to produce a fictive story about the mental state of a stranger whom they imagined meeting on a park bench. Brain activity during this TOM task was contrasted to that elicited by a control task consisting in reading aloud a story requiring no mental state attribution. The TOM task activated the medial frontal cortex, the superior frontal cortex, the anterior and retrosplenial cingulate, and the anterior temporal pole; most of these activations were observed in the left hemisphere. In an event-related potential experiment (Sabbagh and Taylor, 2000), participants were invited to read narratives and answer questions about them. One set of stories dealt with beliefs of another person (TOM task) while the other had to do with non-mentalistic information. Results indicated greater left frontal activity during the TOM task. Gallagher and Frith (2003) reviewed neuroimaging and lesion studies of TOM and proposed that one region is consistently associated with "mentalizing": the anterior paracingulate cortex bilaterally. In a more recent review of literature, Lieberman (2006) identified the dorsomedial prefrontal cortex. For additional examples of bilateral and left hemisphere involvement in TOM, see e.g., den Ouden et al. (2006), Rilling et al. (2004), Saxe and Powell (2006), and Takeuchi et al. (2002).

To recap then, although self-awareness and TOM are related, they are no equivalent; thus, the possibility that TOM might be primarily associated with to right hemisphere activity does not allow one to conclude that self-awareness *per se* is located in that same hemisphere. Besides, as indicated above, the notion of right hemispheric superiority for TOM remains highly controversial.

Self-awareness and the Left Hemisphere

So far I have been suggesting that Keenan et al.'s attempt at localizing self-awareness in the brain by using an indirect route – by looking at brain activity during self-recognition and TOM tasks – is inconclusive. In this section I take a more direct approach and review some research in which brain activity was recorded during tasks specifically designed to tap into self-awareness as defined in the target paper. Here too, some studies do report a right hemisphere bias during processing of self-information (e.g., Craig et al., 1999; Fossati et al., 2003; Schmitz et al., 2004); but numerous experiments also show *bilateral* and/or *left* activation when participants reflect on various self-aspects.

For instance, Johnson et al. (2005) invited volunteers to make decisions about color preference (subjective and internal – self-referential – condition) and color similarity (external and veridical – non self-referential – condition). fMRI results indicated that in the self-referential condition the anterior medial prefrontal and retrosplenial corticles were significantly more activated than during the control condition. Importantly, the left hemisphere in that study was more active than the right. In Lieberman et al.'s (2004) experiment, participants evaluated the self-descriptiveness of trait words as a function of how much experience they had in relevant activity domains. When participants made judgments in their high-experience domain, the ventromedial prefrontal cortex, nucleus accumbens, amygdala, and lateral temporal cortex were recruited, mostly in the left hemisphere. When participants assessed their low-experience domain, the right lateral prefrontal cortex was the only area differentially activated. In Goldberg et al.'s study (2006), subjects viewed various images and were asked to reflect on the emotional response produced in them by these stimuli; the control task consisted in

categorizing the pictures into groups (e.g., animal/no-animal). (Another experiment within the same study used auditory stimuli.) Greater activity for the self-awareness task mainly occured in the left prefrontal cortex.

These are just three illustrations taken from a pool of studies that suggest bilateral/left brain activity during self-referential processing. Other examples for various self-aspects can be found in Conway et al. (1999) (autobiographical memory); Ochsner et al. (2004) (emotions); Seger et al. (2004) and Zysset et al. (2002) (evaluative judgments/preferences); D'Argembeau et al. (2005), Gusnard et al. (2001), Johnson et al. (2002), Kelly et al. (2002), Kircher et al. (2000), and Lou et al. (2004) (traits and attitudes); and Kjaer et al. (2002) (traits and physical appearance).

Toward the end of the target article, Keenan et al. state that "We therefore find that the data support the hypothesis that the right hemisphere is dominant for higher-order consciousness" (p. 702). The most detrimental piece of evidence that exists to question this conclusion can be found in a research report cited by Keenan's team to support that very same view. Sperry et al. (1979) tested self-recognition in the disconnected hemispheres of a split-brain patient and found (as reported by Keenan et al., p. 697) that "Certainly, the right hemisphere was capable of self-recognition. He [Sperry] concluded that the right hemisphere was at least equal to the left in terms of consciousness". This strongly suggests that the left hemisphere *too* is self-aware, and indeed, "… Conscious function in the disconnected left, language dominant hemisphere is relatively easy to determine through direct verbal communication" (Sperry et al., 1979, p. 153). Meaning that the left hemisphere of split-brain patients is clearly self-aware since it can verbally comment on its identity, current feelings, future goals, aspirations, etc. How can the right hemisphere be dominant for self-reflecting activities if the left hemisphere is *also* fully self-aware?

Conclusion

In this commentary I argued that at a conceptual level, self-recognition and TOM are not equivalent to self-awareness. Consequently, even if self-recognition and TOM were the result of right hemispheric activity, it would not justify the claim that self-awareness is primarily located in that hemisphere. At an empirical level, there is ample evidence that self-recognition, TOM, and self-awareness cannot be found in one specific brain area or hemisphere. The distributed nature of self-related processes is made clear in Gillihan and Farah's (2005) recent review of literature that evaluates the supposedly unique nature of the self. Gillihan and Farah compiled activation maxima observed across numerous imaging experiments using self-reflective tasks and neuropsychological case-studies assessing self-awareness. They conclude that "Had the points clustered in certain regions or along certain networks, the hypothesis of a unitary self system would have been supported. However, neither the imaging nor the patient data implicate common brain areas across different aspects of the self. This is not surprising because there is generally little clustering even within specific aspects of the self" (p. 94). Consistent with this observation is Kircher's suggestion (2002, p. 690) that "... there is no unique center in the brain for self-relevant processing". Turk et al. (2003, p. 1) concur: "The available evidence suggests that the sense of self is widely distributed throughout the brain".

One suspects that Keenan et al.'s effort at localizing self-awareness in the right hemisphere might at least be partially motivated by a legitimate need to counterbalance the "left hemisphere bias – the view that there is a left "dominant" hemisphere and a right "minor" hemisphere (see target article, p. 697). Unfortunately, claiming that the right hemisphere is dominant for self-awareness generates another bias – albeit the opposite one.

References

Abu-Akel A. A neurobiological mapping of theory of mind. *Brain Research Reviews, 43:* 29-40, 2003.

Amodio DM and Frith CD. Meeting of minds: the medial frontal cortex and social cognition. *Nature Reviews Neuroscience, 7:* 268-277, 2006.

Amsterdam B. Mirror self-image reactions before age two. *Development Psychobiology, 5:* 297-305, 1972.

Astington JW and Jenkins JM. A longitudinal study of the relation between language and Theory-of-Mind development. *Developmental Psychology, 35:* 1311-1320, 1999.

Brady N, Campbell M and Flaherty M. My left brain and me: A dissociation in the perception of self and others. *Neuropsychologia, 42:* 1156-1161, 2004.

Calarge C, Andreasen NC and O'Leary DS. Visualizing how one brain understands another: A PET study of Theory of Mind. *American Journal of Psychiatry, 160:* 1954-1964, 2003.

Conway MA, Turk DJ, Miller SL, Logan J, Nebes RD, Meltzer CC and Becker JT. A positron emission tomography (PET) study of autobiographical memory retrieval. *Memory, 7:* 679-702, 1999.

Craik F, Moroz T, Moscovitch M, Stuss D, Winocur G, Tulving E and Kapur S. In search of the self: A positron emission tomography study. *Psychological Science, 10:* 26-34, 1999.

Cunningham C and Glenn S. Self-awareness in young adults with Down Syndrome: I. Awareness of Down syndrome and disability. *International Journal of Disability, Development and Education: 51,* 2004.

D'Argembeau A, Collette F, Van der Linden M, Laureys S, Del Fiore G, Degueldre C, Luxen A and Salmonc E. Self-referential reflective activity and its relationship with rest: A PET study. *NeuroImage, 25:* 616-624, 2005.

Decety J and Sommerville JA. Shared representations between self and other: A social cognitive neuroscience view. *Trends in Cognitive Sciences, 7:* 527-533, 2003.

Decety J and Grezes J. The power of simulation: Imagining magining one's own and other's behavior. *Brain Research, 1079:* 4-14, 2006.

Den Ouden H, Frith U, Frith C and Blackmore SJ. Thinking about intentions. *NeuroImage, 28:* 787-796, 2005.

Feinberg TE and Keenan JP. Where in the brain is the self? *Consciousness and Cognition, 14:* 661-678, 2005.

Gallagher HL and Frith CD. Functional imaging of 'theory of mind'. *Trends in Cognitive Sciences, 7:* 77-83, 2003.

GALLUP GG. Chimpanzees: Self-recognition. *Science, 167:* 86-87, 1970.
GALLUP GG. Self-awareness and the evolution of social intelligence. *Behavioural Processes, 42:* 239-247, 1998.
GALLUP GG, Anderson JL and Shillito DP. The mirror test. In Bekoff M, Allen C, and Burghardt GM (Eds), *The Cognitive Animal: Empirical and Theoretical Perspectives on Animal Cognition.* University of Chicago Press, 2002, pp. 325-333.
GARFIELD JL, PETERSON CC and PERRY T. Social cognition, language acquisition and the development of the theory of mind. *Mind and Language, 16:* 494-541, 2001.
GILLIHAN ST and FARAH MJ. Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience. *Psychological Bulletin, 131:* 76-97, 2005.
GOLDBERG II, HAREL M and MALACH R. When the brain loses its self: Prefrontal inactivation during sensorimotor processing. *Neuron, 50:* 329-339, 2006.
GUSNARD DA, AKBUDAK E, SHULMAN GL and RAICHLE ME. Medial prefrontal cortex and self-referential mental activity: Relation to a default mode of brain function. *Proceedings of the National Academy of Sciences, 98:* 4259-4264, 2001.
HARRIS LT, TODOROV A and FISKE ST. Attributions on the brain: Neuro-imaging dispositional inferences, beyond 'Theory of Mind'. *NeuroImage, 28:* 763-769, 2005.
HESSLOW G. Conscious thought as simulation of behavior and perception. *Trends in Cognitive Sciences, 6:* 242-247, 2002.
HEYES CM. Theory of mind in nonhuman primates. *Behavioral and Brain Sciences, 21:* 101-134, 1998.
JACKSON PL, BRUNET E, MELZOFF AN and DECETY J. Empathy examined through the neural mechanisms involved in imagining how I feel versus how you feel pain. *Neuropsychologia, 44:* 752-761, 2006.
JOHNSON SC, BAXTER LC, WILDER LS, PIPER JG, HEISERMAN JE and PRIGATANO GP. Neural correlates of self-reflection. *Brain, 125:* 1808-1814, 2002.
JOHNSON SC, SCHMITZ TW, KAWAHARA-BACCUS TN, ROWLEY HA, ALEXANDER AL, LEE J and DAVIDSON RJ. The cerebral response during subjective choice with and without self-reference. *Journal of Cognitive Neuroscience, 17:* 1897–1906, 2005.
JOHNSON A, BARNACZ A, YOKKAICHI T, RUBIO J, RACIOPPI C, SHACKELFORD T, FISHER M and KEENAN JP. Me, myself, and lie: The role of self-awareness in deception. *Personality and Individual Differences, 38:* 1847-1853, 2005.
JOIREMAN JA, PARROTT L and HAMMAERSLA J. Empathy and the self-absorption paradox: Support for the distinction between self-rumination and self-reflection. *Self and Identity, 1:* 53-65, 2002.
JOIRENAM JA. Empathy and the self-absorption paradox II: Self-rumination and self-reflection as mediators between shame, guilt, and empathy. *Self and Identity, 3:* 225-238, 2004.
KEENAN JP, WHEELER MA, GALLUP GG and PASCUAL-LEONE A. Self-recognition and the right prefrontal cortex. *Trends in Cognitive Sciences, 4:* 338-344, 2000.
KEENAN JP, NELSON A, O'CONNOR M and PASCUAL-LEONE A. Self-recognition and the right hemisphere. *Nature, 409:* 305, 2001.
KEENAN JP, FALK D and GALLUP GG. *The Face in the Mirror: The search for the origins of consciousness.* New York: Harper Collins Publishers, 2003.
KEENAN JP, RUBIO J, RACIOPPI C, JOHNSON A and BARNACZ A. The right hemisphere and the dark side of consciousness. *Cortex, 41:* 695-704, 2005.
KELLY WM, MACRAE CN, WYLAND CL, CAGLAR S, INATI S and HEATHERTON TF. Finding the Self? An Event-Related fMRI Study. *Journal of Cognitive Neuroscience, 14:* 785-794, 2002.
KIRCHER TTJ, SENIOR C, BULLMORE E, BENSON PJ, SIMMONS A, BARTELS M and DAVID AS. Towards a functional anatomy of self-processing: Effects of faces and words. *Cognitive Brain Research, 10:* 133-144, 2000.
KIRCHER TTJ, SENIOR C, BULLMORE E, BRAMMER MJ, BENSON PJ, SIMMONS A, BARTELS M and DAVID AS. Recognising one's own face. *Cognition, 78:* B1-B15, 2001.
KIRCHER TTJ, BRAMMER MJ, SIMMONS A, BARTELS M and DAVID AS. The neural correlates of intentional and incidental self processing. *Neuropsychologia, 40:* 683-692, 2002.
KJAER TW, NOVAK M and LOU HC. Reflective self-awareness and conscious states: PET evidence for a common midline parietofrontal core. *NeuroImage, 17:* 1080-1086, 2002.
LEWIS M. Self-conscious emotions and the development of self. In Shapiro T and Emde RN (Eds), *Affect: Psychoanalytic Perspectives.* Madison, CT: International Universities Press, Inc., 1992, pp. 45-73.
LIEBERMAN MD, JARCHO JM and SATPUTE AB. Evidence-Based and Intuition-Based Self-Knowledge: An fMRI Study. *Journal of Personality and Social Psychology, 87:* 421-435, 2004.
LIEBERMAN MD. Social Cognitive Neuroscience: A Review of Core Processes. *Annual Review of Psychology, 58:* 259-289, 2007.
LOU HC, LUBER B, CRUPAIN M, KEENAN JP, NOVAK M, KJAER TW, SACKEIM HA and LISABY SH. Parietal cortex and representation of the mental self. *Proceedings of the National Academy of Science, 101:* 6827-6832, 2004.
MITCHELL JP, BANAJI MR and MACRAE CN. The link between social cognition and self-referential thought in the medial prefrontal cortex. *Journal of Cognitive Neuroscience, 17:* 1306–1315, 2005.
MITCHELL RW. Mental models of mirror-self-recognition: Two theories. *New Ideas in Psychology, 11:* 295-325, 1993.
MITCHELL RW. Subjectivity and self-recognition in animals. In Leary MR and Tangney JP (Eds*), Handbook of self and identity.* New York: Guilford Press, 2002a, pp. 3-15.
MITCHELL RW. Kinesthetic-visual matching, imitation, and self-recognition. In Bekoff M, Allen C, and Burghardt G (Eds), *The cognitive animal.* Cambridge, MA: MIT Press, 2002b, pp. 345-351.
MORIN A. Right hemispheric self-awareness: A critical assessment. *Consciousness and Cognition, 11:* 396-401, 2002.
MORIN A. Let's face it. A review of Keenan, Gallup, and Falk's book "The Face in the Mirror". *Evolutionary Psychology, 1:* 161-171, 2003.
NELSON K. Emerging levels of consciousness in early human development. In Terrace HS and Metcalfe J (Eds), *The missing link in cognition: Origins of self-reflective consciousness.* Oxford Press, 2005, pp. 116-141.
OCHSNER KN, KNIERIM K, LUDLOW DH, HANELIN J, RAMACHANDRAN T, GLOVER J and MACKEY SC. Reflecting upon Feelings: An fMRI Study of Neural Systems Supporting the Attribution of Emotion to Self and Other. *Journal of Cognitive Neuroscience, 16:* 1746-1772, 2004.
PLATEK SM, KEENAN JP, GALLUP GG and MOHAMED FB. Where am I? The neurological correlates of self and other. *Cognitive Brain Research, 19:* 114-122, 2004a.
PLATEK SM, THOMPSON JW and GALLUP GG. Cross-modal self-recognition: The role of visual, auditory, and olfactory primes. *Consciousness and Cognition, 13:* 197-210, 2004b.
POVINELLI DJ. The unduplicated self. In Rochat P (Ed.), *The self in early infancy.* Amsterdam: North-Holland-Elsevier, 1995, pp. 161-192.
RILLING JK, SANFRY AG, ARONSON JA, NYSTROM LE and COHEDA JD. The neural correlates of theory of mind within interpersonal interactions. *NeuroImage, 22:* 1694-1703, 2004.
SABBAGH MA and TAYLOR M. Neural correlates of theory-of-mind reasoning: An event-related potential study. *Psychological Science, 11:* 46-50, 2000.
SAXE R. Against Simulation: the Argument from Error. *Trends in Cognitive Science, 9:* 174-179, 2005.
SAXE R. Why and how to study Theory of Mind with fMRI. *Brain Research, 1079:* 57-65, 2006.
SAXE R and POWELL LJ. It's the thought that counts: Specific brain regions for one component of Theory of Mind. *Psychological Science, 17:* 692-699, 2006.
SEGER CA, STONE M, and KEENAN JP. Cortical activations during judgment about the self and an other person. *Neuropsychologia, 42:* 1168-1177, 2004.
SCHMITZ TW, KAWAHARA-BACCUS TN and JOHNSON SC. Metacognitive evaluation, self-relevance, and the right prefrontal cortex. *NeuroImage, 22:* 941-947, 2004.
SPERRY R, ZAIDEL E and ZAIDEL D. Self-recognition and social awareness in the disconnected minor hemisphere. *Neuropsychologia, 17:* 153-166, 1979.
SUGIURA M, WANABE J, MAEDA Y, MATSUE Y, FUKUDA H and KAWASHIMA R. Cortical mechanisms of visual self-recognition. *NeuroImage, 24:* 143-149, 2005.
TAKEUCHI M, HARADA M and NISHITANI H. Deficiency of "theory of mind" in autism estimated by fMRI. *International Congress Series, 1232:* 737-740, 2002.
TRAPNELL PD and CAMPBELL JD. Private self-consciousness and the Five-Factor Model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology, 76:* 284-304, 1999.
TURK DJ, HEATHERTON TF, KELLEY WM, FUNNELL MG, GAZZANIGA MS and MACREA CN. Mike or me? Self-recognition in a split-brain patient. *Nature Neuroscience, 5:* 841-842, 2002.

TURK DJ, HEATHERTON TF, MACREA CN, KELLEY WM and GAZZANIGA MS. Out of Contact, Out of Mind: The Distributed Nature of the Self. *Annals of the New York Academy of Sciences, 1001:* 1-14, 2003.

UDDIN LQ, RAYMAN J and ZAIDEL E. Split-brain reveals separate but equal self-recognition in the two cerebral hemispheres. *Consciousness and Cognition, 14:* 633-640, 2005.

VOGELEY K, BUSSFELD P, NEWEN A, HERRMANN S, HAPPE F, FALKAI P, MAIER W, SHAH NJ, FINK GR and ZILLES K. Mind reading: Neural mechanisms of theory of mind and self-perspective. *NeuroImage, 14:* 170-181, 2001.

ZYSSET S, HUBER O, FERSTI E and VON CRAMON DY. The Anterior Frontomedian Cortex and Evaluative Judgment: An fMRI Study. *NeuroImage, 15:* 983-991, 2002.

Alain Morin, Behavioral Sciences, Mount Royal College, 4825 Mount Royal Gate S.W., Calgary, Alberta, Canada T3E 6K6. e-mail: amorin@mtroyal.ca

(*Received 26 May 2006, accepted 31 May 2006; Action Editors Jordan Grafman and Giorgio Ascoli*)