

Self-Awareness Part 2: Neuroanatomy and Importance of Inner Speech

Alain Morin*

Department of Psychology, Mount Royal University

Abstract

The present review of literature surveys two main issues related to self-referential processes: (1) Where in the brain are these processes located, and do they correlate with brain areas uniquely specialized in self-processing? (2) What are the empirical and theoretical links between inner speech and self-awareness? Although initial neuroimaging attempts tended to favor a right hemispheric view of self-awareness, more recent work shows that the brain areas which support self-related processes are located in both hemispheres and are not uniquely activated during self-reflective tasks. Furthermore, self-awareness at least partially relies on internal speech. An activation of Broca's area (which is known to sustain inner speech) is observed in a significant number of brain-imaging studies of self-reflection. Loss of inner speech following brain damage produces self-awareness deficits. Inner speech most likely can internally reproduce social mechanisms leading to self-awareness. Also, the process of self-reflection can be seen as being a problem-solving task, and self-talk as being a cognitive tool the individual uses to effectively work on the task. It is noted that although a large body of knowledge already exists on self-awareness, little is known about individual differences in dispositional self-focus and types of self-attention (e.g., rumination versus self-reflection).

Introduction

Self-awareness constitutes the capacity to become the object of one's own attention (Duval & Wicklund, 1972). A self-aware organism is actively identifying, processing, and storing information about the self (Morin, 2004). As Figure 1 below suggests, research on self-awareness and related notions (e.g., self-concept, self-regulation, self-recognition) has grown exponentially over the last few decades. The number of published papers with the words "self-awareness", "self-consciousness", and "self-perception" in their title basically doubled from the 1970s to the 1980s and in the past decade was 10 times that of the 1960s. (Of course a similar increment trend applies to many other psychological concepts.)

Some of this body of work was reviewed in a Part 1 article published in this journal (Morin, 2011). The review presented various definitions of self-related processes, existing measures, main effects and functions of self-attention, and antecedents of self-awareness. In doing so Part I addressed the "how", "why", and "when" of self-awareness – *how* do our brain, cognitive processes, and social environment generate self-awareness? *Why* are we self-aware – what functions does self-observation serve? And *when*, in what situations, are we most likely to engage in self-reflection? Here the "how" question will be further examined: *how* does language, and more specifically inner speech, help one to identify self-aspects? Additionally, the "where" question will be raised: *where* are self-reflective processes located in the brain? Actually, are there brain regions uniquely associated with self-reflection? Let us start with the localization issue.

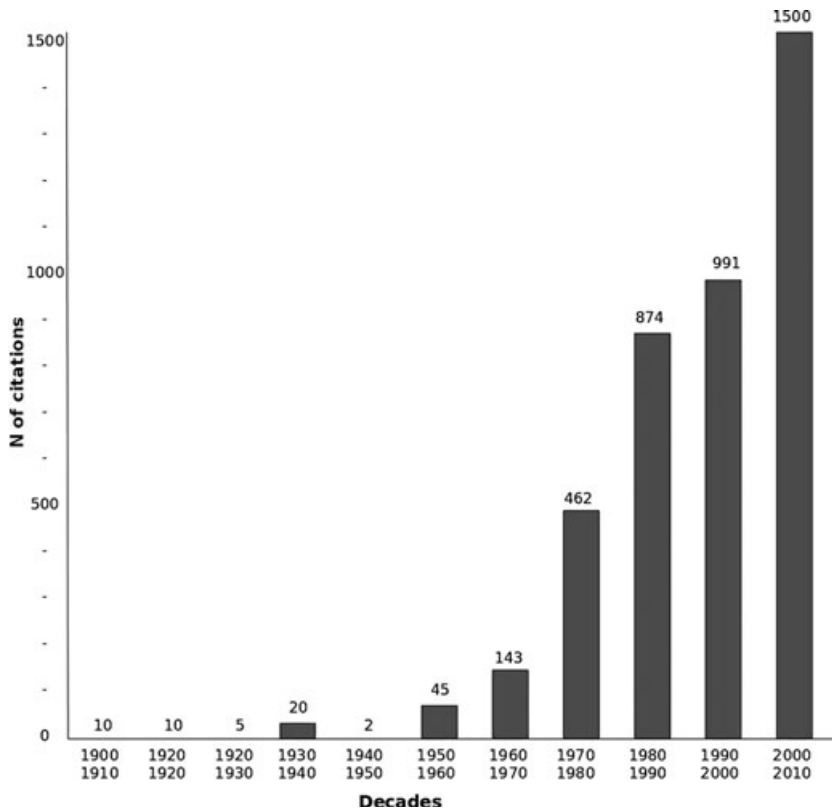


Figure 1 Citation frequencies obtained from PsycINFO, Medline, and PsycARTICLES in peer-reviewed journal articles for “self-awareness”, “self-consciousness”, and “self-perception” from 1900 to 2010.

Neuroanatomy

Early studies

Initial attempts at localizing self-related processes in the brain operationally defined self-awareness as the ability to recognize one’s face in a mirror or on a photograph (Morin, 2010). There are numerous problems with this approach, some of which will be addressed below (see Morin, 2007). Spontaneous mirror-guided self-exploration has only been objectified in human primates, chimpanzees, orangutans, and some bonobos, elephants, dolphins, and Australian magpies (see Bard, Todd, Bernier, Love, & Leavens, 2006; Plotnik, de Waal, & Reiss, 2006; Prior, Schwartz, & Gunturkun, 2008; Reiss & Marino, 2001). These animals also pass the mark test (e.g., Gallup, Anderson, & Shillito, 2002): they successfully try to remove a red dot that has been applied to their brow or forehead (or throat feathers in magpies’ case) while looking at themselves in a mirror. Gallup’s contention (e.g., 1968, 1985, 1997) is that such self-directed behaviors indicate that the organism can become the object of its own attention. Furthermore, self-recognition in front of a mirror presupposes *precognition* of the self (i.e., already existing self-knowledge) – self-awareness.

Premature conclusions favored a right prefrontal account of the neuroanatomy of self-awareness. Four types of studies have been used to investigate the neural correlates of

self-face recognition: behavioral, lesion, split-brain, and functional imaging. Behavioral and lesion studies tend to support a right hemisphere dominance view of self-face processing; split-brain and functional-imaging data do not. Behavioral studies (e.g., Keenan et al., 1999) invite healthy participants to decide if a visual stimulus represents their own face or that of either a familiar person or an unknown individual by pressing buttons with the right or left hand. A left-hand/right hemisphere advantage (i.e., faster reaction times) is observed when participants respond to self-faces, but not to other faces. Lesion studies present cases of patients with right hemisphere damage who fail to recognize themselves in the mirror (e.g., Keenan, Rubio, Racioppi, Johnson, & Barnacz, 2005). Note that very few patients actually exhibit this condition (Rosa, Lassonde, Pinard, Keenan, & Belin, 2008).

Self-face recognition was first studied in two split-brain patients by Preilowski (1977), who presented various photographs of faces, including their own face, to the left and right hemispheres of two patients; the dependent measure was galvanic skin response as an indicator of arousal. Both patients showed significantly greater skin response when self-faces were presented to the right hemisphere than when they were projected to the left. Note that using an arousal measure to infer self-recognition is ambiguous at best. Published reports of actual self-recognition tasks in split-brain patients do not replicate Preilowski's clear-cut lateralized result. To illustrate, in an experiment conducted by Sperry, Zaidel, and Zaidel (1979), both hemispheres of two split-brain patients were capable of self-recognition. Both patients correctly chose a picture of themselves (among a series of pictures of family members and friends) with their right hand when the information was presented to the left hemisphere, and vice versa. Other studies found similar results (e.g., Uddin, Rayman, & Zaidel, 2005) or observed a *left* hemisphere superiority for self-recognition (Turk et al., 2002).

In a typical functional-imaging study of self-face recognition (e.g., Platek, Keenan, Gallup, & Mohamed, 2004), healthy volunteers are asked to make identity judgments about their own face, the face of a friend, and the face of a stranger while brain activity is being recorded with positron emission tomography (PET) or functional magnetic resonance imaging (fMRI). Although initial reports tended to support the right hemispheric view (all of which interestingly came out of Keenan's laboratory), a recent meta-analysis of nine functional-neuroimaging studies of self-face recognition (Platek, Wathne, Tierney, & Thomson, 2008) describes a wider distributed, *bilateral*, network that involves the left fusiform gyrus, bilateral middle and inferior frontal gyri, and right precuneus. This is clearly at odds with proposals such as "neural substrates of the right hemisphere may selectively participate in processes linked to self-awareness" (Keenan, Nelson, O'Connor, & Pascual-Leone, 2001, p. 305).

One major problem when reducing self-awareness to self-recognition is that one most likely measures a rudimentary manifestation of self-awareness – not the full-blown version (Morin, 2002). Self-recognition obviously implies some form of self-awareness, but the question is: what type or level of self-awareness is involved? Mitchell (1993, 2002) and Povinelli (1995) both argue that the only prerequisite for self-recognition is a knowledge of one's body. All the organism needs to effectively self-recognize is a mental representation of its own physical self; the organism matches the kinesthetic representation of the body and face with the image seen in the mirror and concludes that "it's me." This view suggests that an awareness of one's mental states is not required for successful self-recognition. Perhaps more importantly, conceptually speaking, self-recognition and self-awareness cannot be equated; thus even if studies were able to show that the former is located in the right hemisphere (and they don't), it would not signify that the latter is produced by the same hemisphere.

Beyond self-recognition

Do other forms of more “mental” self-reflection produce reliably localized brain activation? Does the suggested right hemisphere superiority for self-recognition also apply to autobiographical retrieval, assessment of one’s current emotional experience, or description of one’s personality traits? Gillihan and Farah (2005) calculated activation maxima gathered across various imaging experiments using self-related tasks and neuropsychological case studies evaluating patients’ self-awareness. In a classic personality trait study (e.g., Kelley et al., 2002), participants decide if adjectives describe themselves (self-condition) or a well-known person (other condition), or if adjectives are printed in capitals or lowercase letters (control condition). Ten personality trait studies in Gillihan and Farah’s meta-analysis (2005) reported activation in both the left and right hemispheres, including in the right middle temporal gyrus and inferior parietal lobe, and left inferior frontal gyrus and superior temporal gyrus. In a standard brain-imaging study of autobiographical memory (e.g., Fink et al., 1996), participants are scanned while they listen to a narrative recounting a memory of their own (self-condition) and a narrative describing another person’s memory (control condition). Gillihan and Farah examined three such studies and found activation in a left-lateralized network that included regions in the frontal, temporal and posterior cortices, as well as the cerebellum and a number of subcortical structures (also see Svoboda, McKinnon, & Levine, 2006).

Northoff et al. (2006) reviewed 27 imaging studies of the self and observed neural activity in the cortical midline structures during self-inferential tasks across many self-domains, including personality traits judgements, autobiographical retrieval, and emotions assessment. In a representative brain-imaging study of emotions (e.g., Goldberg, Harel, & Malach, 2006), volunteers view various images and are invited to reflect on the emotional response that these stimuli produce; the control task may consist in categorizing the pictures into groups (e.g., color/black-and-white). Phan, Wager, Taylor, and Liberzon (2004) reviewed 55 functional-neuroimaging experiments of emotions and found significant activation in the medial prefrontal cortex, amygdala, anterior cingulate cortex, and insula.

The REST (Random Episodic Silent Thinking) state represents an introspective condition in which participants actively reflect on their current, past, or future goals, emotions, needs, behavior, physiological sensations, etc. (Gusnard, Akbudak, Shulman, & Raichle, 2001). In a typical REST experiment (e.g., Mazoyer et al., 2001), participants are simply asked to sit with their eyes closed. The REST condition recruits most brain regions that have also been shown to be active during self-awareness tasks (Wickera, Ruby, Royet, & Fonlupt, 2003). Schilbach, Eickhoff, Rotarska-Jagiela, Fink, and Vogeley (2008) investigated brain areas that are reliably *deactivated* during active tasks: these areas should theoretically be those that are activated at rest but inhibited during cognitively challenging tasks. The team performed a deactivation analysis across 12 fMRI studies requesting cognitive work and observed *decreased* neural activity in the left angular gyrus, bilateral medial frontal cortex, and the precuneus bilaterally.

The quest for localizing self-processes in the brain has led researchers to perform a huge number of imaging studies in numerous self-domains, including self-recognition, traits, autobiography, emotions, REST, intentions, agency, preferences, and mental time travel (see Morin & Hamper, forthcoming for a review). As seen above, different self-referential tasks engage a wide network of sites located in both hemispheres of the brain. The consensus is that the following regions are recruited during self-related processing: cortical medial structures, which include ventromedial and dorsomedial prefrontal cortex,

precuneus, insula, posterior cingulate cortex, left and right temporoparietal junction, and anterior cingulate cortex (Salmon et al., 2008). Figure 2 depicts these brain areas.

The truth about the self-brain problem: Still unknown

The key question that needs to be raised now is: are the above-mentioned brain regions uniquely activated during self-processing? In other words, as Feinberg and Keenan (2005) have asked, “where in the brain is the self?” The answer to both questions is still controversial. One of the very first brain-imaging studies of self-awareness (Craig et al., 1999) reported that “every significant activation in the (self-condition) was also found in either the (other person condition) or the (general semantic) condition, or both” (p. 30). This is the main point made by Gillihan and Farah (2005): humans’ representation of the self is not special – it is associated with brain areas that are physically and functionally similar to those recruited for general cognitive processing. A unitary system for the self does not seem to exist despite our subjective experience of a unified self. Thus, while early localization studies of the self took a rather phrenological stance, some researchers are suggesting a more distributed and nonlocalized view of the neuroanatomy of self-awareness (Turk, Heatherton, Macrae, Kelley, & Gazzaniga, 2003). Yet more recently, in a particularly objective and quantitative meta-analysis, Van der Meer, Costafreda, Aleman, and David (2010) found the ventral and dorsal medial prefrontal cortex to be uniquely implicated in self-processing.

Legrand and Ruby (2009) further proposed that two general cognitive processes utilized when one is engaged in self-referential processing are memory recall and inferential reasoning. They suggest that most self-reflection tasks employed in brain-imaging studies require one form or another of memory and evaluation involving a certain degree of

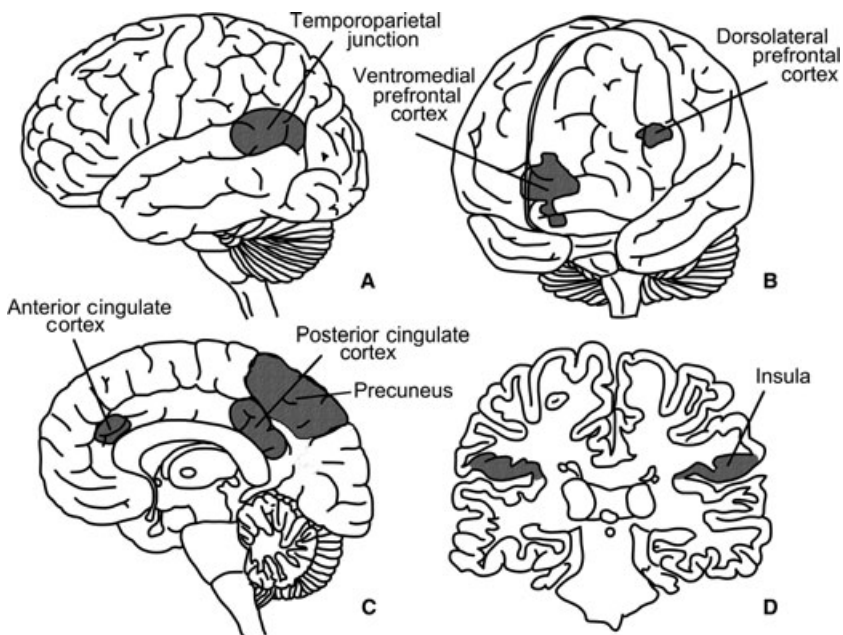


Figure 2 Brain areas known to be involved during self-referential activity. A, B, C and D indicate different views of the brain.

uncertainty (e.g., does this personality trait apply to me?). Consistent with their hypothesis, Legrand and Ruby (2009) presented evidence that most brain areas recruited during self-reflection are also activated during memory recall and inferential reasoning. Yet in his more recent meta-analysis, Van Overwalle (2011) examined studies using mentalizing (including self) tasks and contrasted brain activation found in these with studies recruiting a wide variety of cognitive abilities such as linguistic arguments of induction and deduction, probabilistic reasoning, relational judgments, analogies, and transitive inferences. “The evidence demonstrates that reasoning with mentalizing differs reliably from cognitive reasoning without mentalizing...” (p. 1595); specifically, the medial prefrontal cortex was shown to be activated mainly when cognitive tasks included content about the self. This rather supports the self-specificity view or the neuroanatomy of self-awareness. The debate remains unresolved.

Inner Speech

Background

Let us now address the “how” issue: how do we become self-aware? What are the specific mechanisms underlying self-reflection? Some such mechanisms have been discussed in Morin (2011) – namely, proprioception, mental imagery, and the social and physical environments. Here the role of language, and more specifically inner speech, will be emphasized.

Inner speech is speech for self-articulated silently (e.g., Langdon, Jones, Connaughton, & Fernyhough, 2009; Zivin, 1979). Other related expressions are self-talk (which includes talking to oneself aloud), private speech (audible self-talk emitted by children), phonological loop, self-verbalizations, and internal dialog (Morin, forthcoming). Inner speech serves various functions, among which self-control/regulation (e.g., Harris, 1990; Tullett & Inzlicht, 2010; Vygotsky, 1943/1962; Winsler, 2009), problem-solving (e.g., Roberts, 1979), planning (Lidstone, Meins, & Fenyhough, 2010; Meacham, 1979), memory (including autobiography) (Baddeley & Hitch, 1974; Larsen, Schrauf, Fromholt, & Rubin, 2002), task switching performance (Karbach & Kray, 2007), language in general (Levine, Calvanio, & Popovics, 1982; Verstichel, Bourak, Font, & Crochet, 1997), and reading (Abramson & Goldinger, 1997; Sokolov, 1972). Some psychological disorders such as anxiety and depression are mediated by dysfunctional self-talk (e.g., Beazley, Glass, Chambless, & Arnkoff, 2001). Inner speech represents a fundamental human cognitive activity as about one-fourth of people’s conscious waking life consists of inner speech (Heavey & Hurlburt, 2008). Yet overall, and remarkably, inner speech has been understudied when compared to other important psychological concepts. To illustrate, only seven out of 32 sampled Introductory Psychology textbooks (21.8%) mentioned inner speech and/or related terms in their subject indexes, and 84.5% of over 100 key psychological terms (e.g., cognitive dissonance, altruism) were cited more often than inner speech in PsycINFO from 1900 to 2009 (Morin, 2009a).

One relatively overlooked role played by inner speech is self-reflection (see DeSouza, DaSilveira, & Gomes, 2008; Martínez-Manrique & Vicente, 2010; Morin, 2005; Neuman & Nave, 2010; Werning, 2010). The idea that inner speech is linked to consciousness and self-awareness is not new. Plato (cited in Blachowicz, 1999), as well as some contemporary philosophers and psychologists (e.g., Carruthers, 1996; Dennett, 1991; DeWitt, 1975; Flanagan, 1992; Jaynes, 1986; Mead, 1934; Sokolov, 1972; Stamenov, 2003) have

alluded to such a link. What *is* novel is empirical evidence establishing connections between self-reflection and the inner voice.

Empirical evidence

At a very fundamental level, the plain fact that we can talk to ourselves *about ourselves* suggests that inner speech plays a role in self-awareness. Indeed, people report talking to themselves mostly about the self, and more specifically (in decreasing order) when evaluating the self and reflecting on one's emotions, physical appearance, and relationships (Morin, Uttl, & Hamper, forthcoming). A significant positive correlation has repeatedly been observed between various validated measures of private self-focus frequency and use of inner speech (e.g., Morin, Everett, Turcotte, & Tardif, 1993; Schneider, 2002; Schneider, Pospeschill, & Ranger, 2005; Siegrist, 1995). This indicates that the more people reflect on the self the more they tend to engage in self-talk – and/or vice versa. If inner speech plays a significant role in self-referential activities, then the latter should be compromised when self-talk is lost following brain injury. This is exemplified by Jill Bolte Taylor's case study (2006), where she details her experience of suffering from a left hemispheric stroke produced by a congenital arteriovenous malformation that caused a loss of inner speech. Her phenomenological description suggests that this impairment produced a general self-awareness deficit as well as more specific dysfunctions related to her sense of individuality, retrieval of autobiographical memories, and self-conscious emotions (Morin, 2009b; Moss, 1972). Related to Taylor's case study is the observation by rehabilitated brain-injured patients that their conscious experience returned in parallel with inner speech (Ojemann, 1986). Conversely, healthy individuals report inner speech inhibition when they shift from wakefulness to sleep (Rusalova, 2005).

Both inner and outer speech are produced by Broca's area, also known as the left inferior frontal gyrus (LIFG) (e.g., McGuire et al., 1996). Figure 3 above depicts this location. Based on this observation, Morin and Hamper (forthcoming; also see Morin & Michaud, 2007) reasoned that an activation of the LIFG should be found in a significant number of brain-imaging studies of self-awareness. In addition, they predicted that inner speech use should be greater in conceptual-abstract self-domains (e.g., personality traits, autobiography) than in perceptual-concrete self-domains (e.g., agency, self-recognition). To test these ideas, 134 studies measuring brain activity during self-referential tasks were reviewed. Sixty percent of all studies identified LIFG activity across self-awareness tasks,

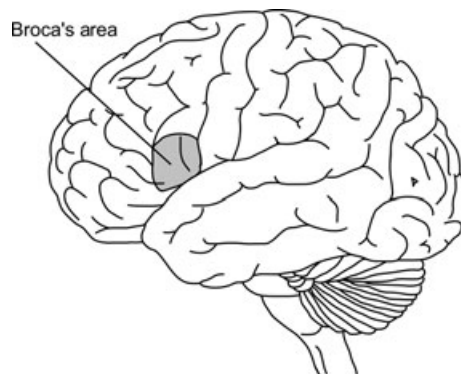


Figure 3 Localization of Broca's area (LIFG) in the brain.

and LIFG activation was more frequently noted during conceptual tasks (70%) than during perceptual tasks (25%). Figure 4 summarizes these results for five self-domains.

One more indirect piece of evidence in favor of a link between inner speech and self-reflection stems from research on autism. One main deficit underlying autism is a poor ability to reflect on oneself, which in turn may be responsible for weak mentalizing abilities – that is, thinking about others' mental states (e.g., Baron-Cohen, 2001; Birch & Bloom, 2004; Frith & Frith, 2003; Silani et al., 2008). A relation between Theory-of-Mind (ToM) abilities and language development has been proposed (Garfield, Peterson, & Perry, 2001; Milligan, Astington, & Dack, 2007), as well as between ToM and inner speech (Whitehouse, Mayberry, & Durkin, 2006; Winsler, Abar, Feder, Rubio, & Schunn, 2007). More specifically, autistic children tend to under-use inner speech when working on various cognitive tasks (Holland & Low, 2010) and normal adults perform poorly on a false-belief task under inner speech suppression conditions (Newton & de Villiers, 2007). To the extent that ToM and self-awareness both rely on common underlying mechanisms, it is conceivable that deficits in the latter be caused by a failure to use inner speech in autistic individuals.

Theoretical considerations

Why would talking to oneself lead to the acquisition of self-information? Several possibilities exist (Morin, 1993, 1995, 2005). One view of consciousness (e.g., Carruthers, 1998, 2002) proposes that one becomes aware of a mental state when one generates a higher-order thought about that state. This stance is consistent with the current proposal: one becomes self-aware when one engages in self-talk (higher-order thought) about one's emotions, thoughts, personality traits, physical characteristics, etc.

Self-talk can also reproduce social mechanisms leading to self-awareness. Cooley (1902) noted that people regularly comment on our personal characteristics and behaviors. These

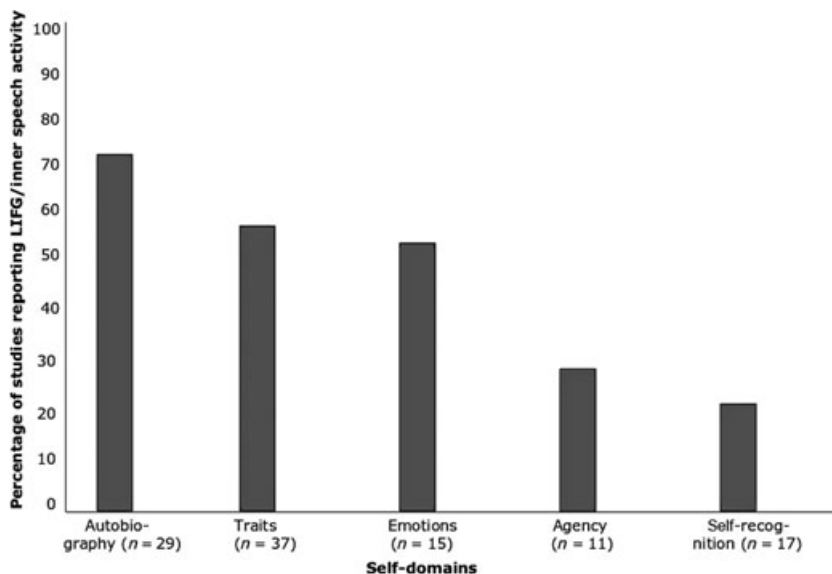


Figure 4 Percentage of studies reporting LIFG/inner speech activity.

reflected appraisals allow one to learn about oneself and can also induce self-awareness. With inner speech one can replicate to oneself appraisals one gets from others. Observations and inferences about one's thoughts, feelings, and behaviors made by others might imprint on one's own inner speech a propensity to address to oneself such remarks. Mead (1934) proposed that encounters with others motivate the individual to take others' perspectives in order to gain an objective point of view on himself or herself. Once in this position, the individual becomes self-aware and can acquire self-information. For example, a person could learn that he or she is patient after observing someone else being rude and impatient in a social setting. Talking to oneself can initiate a fictional dialog where verbalization of an objective, and thus different point of view about oneself is possible.

Yet another suggestion is that inner speech can "translate" self-information into a verbal representation; for example, an emotion (self-information) becomes "I feel happy" (verbal representation) once processed by inner speech. This creates a redundancy within the self-system because in addition to the experienced emotion there now is a verbal representation of it, which in turn creates a virtual distance between the self and self-information. This wedge makes it possible for the self to distance itself from what it is currently experiencing (e.g., an emotion), which facilitates self-observation. Figure 5 schematically illustrates this idea. Note here that the dialogical nature of inner speech, in which an individual asks a question and then answers it (see Blachowicz, 1999), implies a duality of agency in the conversation that fits well with the present "distance" proposal.

Another way to look at the role played by inner speech in self-awareness is to conceive the process of self-reflection as being a problem-solving task, and self-talk as being a cognitive tool the individual uses to reach a "solution" to this "problem". The self is thus seen as a question to be solved (i.e., Who am I? What characterizes me? What behavior did I emit?), where the solution represents self-knowledge, and self-information, the data needed to work out the problem. Talking to oneself while engaged in problem solving tasks significantly facilitates the process (e.g., Fernyhough & Fradley, 2005). Kendall and Hollon (1981) identified four categories of self-statements that assist the process of problem-solving; these can conceivably be applied to the self as follows: (1) self-verbalizations permitting the formulation of a clear definition of the problem ("How did I react? [in a given situation]"); (2) self-verbalizations promoting an optimal approach to the problem ("I should try to remember exactly what happened and everything I did"); (3) evaluative self-statements to praise oneself when a solution is reached ("The first thing I did was Z. Then X happened, and I reacted by saying W. Good! I'm getting somewhere!") or when one needs to readjust one's strategy ("What did H [another person] say? No! That's not important – I need to take my time and think more"), and (4) self-verbalizations enhancing focus on the problem ("I don't need to take G [a given event] into consideration because it's not pertinent").

One last view of the nature of the relation between inner speech and self-awareness is that language allows one to verbally label self-aspects (McCrone, 1999; Zelazo, 2004). This is postulated to greatly facilitate the identification of self-information, especially more abstract and conceptual material (Morin & Hamper, forthcoming). To illustrate,

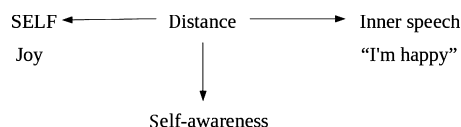


Figure 5 How inner speech is postulated to create a distance between the self and self-information.

one can obviously feel hungry without having to say to oneself “I am hungry”, but one most likely will perceive hunger more acutely (and possibly more intensely) if one talks to oneself about this physiological sensation. Some self-aspects (e.g., opinions, values) probably require verbal labeling in order to fully become available to consciousness. Indeed, how could one realize that one is holding anti-semitic attitudes or hedonistic values without verbally labeling these?

Conclusion

In this review we examined the neuroanatomy of self-awareness as it relates to the laterality question, as well as empirical evidence and theoretical hypotheses pertaining to the importance of self-directed speech in self-reflection. Despite early claims to the contrary, it is pretty clear now that the brain areas which sustain self-inferential processes not only are located in both hemispheres of the brain (not just in the right hemisphere) – they are scattered throughout the brain and activated during other non self-reflective tasks. Any proposal that self-awareness is located in the right mute hemisphere entails that language is not involved in the development of a sense of self. This is inaccurate of course, as self-talk is reliably observed during self-reflection tasks and its loss following brain damage produces self-awareness deficits.

Part 1 of this review (Morin, 2011) dealt with issues related to definitions, measures, effects, functions, and antecedents of self-awareness. Combined with the current contribution, these two articles will hopefully provide the reader with a broad view of what we know about our ability to reflect on the self. Some outstanding research questions nonetheless remain unexplored. For instance, why do people differ in terms of frequency of self-focus? Some environmental variables are known to induce or reduce self-awareness (e.g., Carver & Scheier, 1978; Diener, 1979), but relatively little is known about the potential role of past experiences and psychological dynamics. Similarly, how can we explain individual differences in contents of self-attention? Why is it that some people most frequently engage in positive (self-reflective) self-focus while others more often ruminate about negatively perceived self-aspects (see Trapnell & Campbell, 1999)? Another major unresolved issue is the connection between self-awareness and ToM (Dimaggio, Lysaker, Carcione, Nicolo, & Semerari, 2008; Williams, 2010): both are linked but it is unclear which ability precedes the other – or perhaps they develop hand in hand? Self-awareness arguably represents the crown achievement of human evolution; but in many respects it still remains highly mysterious.

Acknowledgment

I would like to thank Gen Thurlow for designing Figures 2 and 3, and Breanne Hamper, Petra Kamstra and Justine Wilson for editing commentaries on previous versions of this manuscript.

Short Biography

Alain Morin completed his PhD at Laval University (Quebec, Canada) in 1992. Between 1991 and 2001, he taught diverse courses and conducted research in numerous institutions in Quebec and the Maritimes in Canada. He currently teaches Theories of Personality and Social Cognition at Mount Royal University, Alberta, Canada. Morin's main research topic is self-awareness, which includes the cognitive foundations of self-focus

with an emphasis on inner speech, levels of consciousness and self-awareness, the neuro-anatomy of self-referential processes, self-recognition, and animal consciousness. He is also interested in the frequency, content, and functions of naturally occurring inner speech; self-awareness, fame, and self-destruction; the antecedents of self-consciousness; the split-brain phenomenon; and neurophilosophy. Morin publishes his research findings in *Laterality*; *Brain Research Bulletin*; *Consciousness & Cognition*, *Cortex*; *Journal of Mind and Behavior*; *Science & Consciousness Review*; *Brain and Behavioral Sciences*; and *Journal of Consciousness Studies*. He also regularly edits manuscripts for various scientific journals.

Endnote

* Correspondence address: Department of Psychology, Mount Royal University, 4825 Mount Royal Gate SW, Calgary, AB, Canada T3E 6K6. Email: amorin@mtroyal.ca

References

- Abramson, M., & Goldinger, S. D. (1997). What the reader's eye tells the mind's ear: Silent reading activates inner speech. *Perception & Psychophysics*, **59**, 1059–1068.
- Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory* (Vol. 8, pp. 47–89). New York: Academic Press.
- Bard, K. A., Todd, B. K., Bernier, C., Love, J., & Leavens, D. A. (2006). Self-awareness in human and chimpanzee infants: What is measured and what is meant by the mark and mirror test? *Infancy*, **9**, 191–219.
- Baron-Cohen, S. (2001). Theory of mind in normal development and autism. *Prisme*, **34**, 174–183.
- Beazley, M. B., Glass, C. R., Chambless, D. L., & Arnkoff, D. B. (2001). Cognitive self-statements in social phobias: A comparison across three types of social situations. *Cognitive Therapy and Research*, **25**, 781–799.
- Birch, S. A. J., & Bloom, P. (2004). Understanding children's and adults' limitations in mental state reasoning. *Trends in Cognitive Sciences*, **8**, 255–260.
- Blachowicz, J. (1999). The dialogue of the soul with itself. In S. Gallagher & J. Shear (Eds.), *Models of the Self* (pp. 117–200). Exeter, UK: Imprint Academic.
- Carruthers, P. (1996). *Language, Thought and Consciousness: An Essay in Philosophical Psychology*. Cambridge, England: Cambridge University Press.
- Carruthers, P. (1998). Conscious thinking: Language or elimination? *Mind and Language*, **13**, 323–342.
- Carruthers, P. (2002). The cognitive functions of language. *Behavioral and Brain Sciences*, **25**, 657–674.
- Carver, C. S., & Scheier, M. F. (1978). Self-focusing effects of dispositional self-consciousness, mirror presence, and audience presence. *Journal of Personality and Social Psychology*, **36**, 324–332.
- Cooley, C. H. (1902). *Human Nature and the Social Order*. New York: Scribners.
- Craik, F., Moroz, T., Moscovitch, M., Stuss, D., Winocur, G., Tulving, E. et al. (1999). In search of the self: A positron emission tomography study. *Psychological Science*, **10**, 26–34.
- Dennett, D. C. (1991). *Consciousness Explained*. Allen Lane: The Penguin Press.
- DeSouza, M. L., DaSilveira, A., & Gomes, W. B. (2008). Verbalized inner speech and the expressiveness of self-consciousness. *Qualitative Research in Psychology*, **5**, 154–170.
- DeWitt, J. (1975). Consciousness, mind and self: The implications of split-brain studies. *British Journal of the Philosophy of Sciences*, **26**, 41–47.
- Diener, E. (1979). Deindividuation, self-awareness, and disinhibition. *Journal of Personality and Social Psychology*, **37**, 1160–1171.
- Dimaggio, G., Lysaker, P. H., Carcione, A., Nicolo, G., & Semerari, A. (2008). Know yourself and you shall know the other... to a certain extent: Multiple paths of influence of self-reflection on mindreading. *Consciousness and Cognition*, **17**, 778–789.
- Duval, S., & Wicklund, R. A. (1972). *A Theory of Objective Self Awareness*. New York: Academic Press.
- Feinberg, T. E., & Keenan, J. P. (2005). Where in the brain is the self? *Consciousness and Cognition*, **14**, 661–678.
- Fernyhough, C., & Fradley, E. (2005). Private speech on an executive task: Relations with task difficulty and task performance. *Cognitive Development*, **20**, 103–120.
- Fink, G. R., Markowitsch, H. J., Reinkemeier, M., Bruckbauer, T., Kessler, J., & Heiss, W. D. (1996). Cerebral representation of one's own past: Neural networks involved in autobiographical memory. *Journal of Neuroscience*, **16**, 4275–4282.
- Flanagan, O. (1992). *Consciousness Reconsidered*. Cambridge, MA: MIT Press.
- Frith, U., & Frith, C. D. (2003). Development and neurophysiology of mentalizing. *Philosophical Transactions of the Royal Society of London*, **358**, 459–473.

- Gallup, G. G., Jr. (1968). Mirror-image stimulation. *Psychological Bulletin*, **70**, 782–793.
- Gallup, G. G., Jr. (1985). Do minds exist in species other than our own? *Neuroscience and Biobehavioral Reviews*, **9**, 631–641.
- Gallup, G. G., Jr. (1997). On the rise and fall of self-conception in primates. *Annals of the New York Academy of Sciences*, **818**, 73–84.
- Gallup, G. G., Jr., Anderson, J. L., & Shillito, D. P. (2002). The mirror test. In M. Bekoff, C. Allen & G. M. Burghardt (Eds.), *The Cognitive Animal: Empirical and Theoretical Perspectives on Animal Cognition* (pp. 325–333). Chicago: University of Chicago Press.
- Garfield, J. L., Peterson, C. C., & Perry, T. (2001). Social cognition, language acquisition and the development of the theory of mind. *Mind and Language*, **16**, 494–541.
- Gillihan, S., & Farah, M. J. (2005). Is self-related processing special? A critical review. *Psychological Bulletin*, **131**, 76–97.
- Goldberg, I. I., Harel, M., & Malach, R. (2006). When the brain loses its self: Prefrontal inactivation during sensorimotor processing. *Neuron*, **50**, 329–339.
- Gusnard, D. A., Akbudak, E., Shulman, G. L., & Raichle, M. E. (2001). Medial prefrontal cortex and self-referential mental activity: Relation to a default mode of brain function. *Proceedings of the National Academy of Sciences of the United States of America*, **98**, 4259–4264.
- Harris, K. R. (1990). Developing self-regulated learners: The role of private speech and self-instructions. *Educational Psychologist*, **25**, 35–50.
- Heavey, C. L., & Hurlburt, R. T. (2008). The phenomena of inner experience. *Consciousness and Cognition*, **17**, 798–810.
- Holland, L., & Low, J. (2010). Do children with autism use inner speech and visuospatial resources for the service of executive control? Evidence from suppression in dual tasks. *British Journal of Developmental Psychology*, **28**, 369–391.
- Jaynes, J. (1986). Consciousness and the voices of the mind. *Canadian Psychology/Psychologie Canadienne*, **27**, 128–139.
- Karbach, J., & Kray, J. (2007). Developmental changes in switching between mental task sets: The influence of verbal labeling in childhood. *Journal of Cognition and Development*, **8**, 205–236.
- Keenan, J. P., McCutcheon, B., Freund, S., Gallup, G. G., Jr., Sanders, G., & Pascual-Leone, A. (1999). Left hand advantage in a self-face recognition task. *Neuropsychologia*, **37**, 1421–1425.
- Keenan, J. P., Nelson, A., O'Connor, M., & Pascual-Leone, A. (2001). Self-recognition and the right hemisphere. *Nature*, **409**, 305.
- Keenan, J. P., Rubio, J., Racioppi, C., Johnson, A., & Barnacz, A. (2005). The right hemisphere and the dark side of consciousness. *Cortex*, **41**, 695–704.
- Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self? An event-related fMRI study. *Journal of Cognitive Neuroscience*, **14**, 785–794.
- Kendall, P. C., & Hollon, S. D. (1981). Assessing self-referent speech: Methods in measurement of self-statements. In P. C. Kendall & S. D. Hollon (Eds.), *Assessment Strategies for Cognitive-Behavioral Interventions* (pp. 85–118). New York: Academic Press.
- Langdon, R., Jones, S. R., Connaughton, E., & Fernyhough, C. (2009). The phenomenology of inner speech: Comparison of schizophrenia patients with auditory verbal hallucinations and healthy controls. *Psychological Medicine*, **39**, 655–663.
- Larsen, S. F., Schrauf, R. W., Fromholt, P., & Rubin, D. C. (2002). Inner speech and bilingual autobiographical memory: A Polish-Danish cross-cultural study. *Memory*, **10**, 45–54.
- Legrand, D., & Ruby, P. (2009). What is self-specific? Theoretical investigation and critical review of neuroimaging results. *Psychological Review*, **116**, 252–282.
- Levine, D. N., Calvanio, R., & Popovics, A. (1982). Language in the absence of inner speech. *Neuropsychologia*, **20**, 391–409.
- Lidstone, J. S., Meins, E., & Fernyhough, C. (2010). The roles of private speech and inner speech in planning during middle childhood: Evidence from a dual task paradigm. *Journal of Experimental Psychology*, **107**, 438–451.
- Martínez-Manrique, F., & Vicente, A. (2010). “What the...!” The role of inner speech in conscious thought. *Journal of Consciousness Studies*, **17**, 141–167.
- Mazoyer, B., Zago, L., Mellet, E., Bricogne, S., Etard, O., Houde, O. et al. (2001). Cortical networks for working memory and executive functions sustain the conscious resting state in man. *Brain Research Bulletin*, **54**, 287–298.
- McCrone, J. (1999). *Going inside: A Tour Round a Single Moment of Consciousness*. London, England: Faber and Faber.
- McGuire, P. K., Silbersweig, D. A., Murray, R. M., David, A. S., Frackowiak, R. S. J., & Frith, C. D. (1996). Functional anatomy of inner speech and auditory verbal imagery. *Psychological Medicine*, **26**, 29–38.
- Meacham, J. A. (1979). The role of verbal activity in remembering the goals of actions. In G. Zivini (Ed.), *The Development of Self-Regulation through Private Speech* (pp. 237–323). New York: Wiley.
- Mead, G. H. (1934). *Mind, Self, and Society*. Chicago: University of Chicago Press.

- Milligan, K., Astington, J. W., & Dack, L. A. (2007). Language and theory of mind: Meta-analysis of the relation between language ability and false-belief understanding. *Child Development*, **78**, 622–646.
- Mitchell, R. W. (1993). Mental models of mirror-self-recognition: Two theories. *New Ideas in Psychology*, **11**, 295–325.
- Mitchell, R. W. (2002). Subjectivity and self-recognition in animals. In M. R. Leary & J. P. Tangney (Eds.), *Handbook of Self and Identity* (pp. 567–595). New York: Guilford Press.
- Morin, A. (1993). Self-talk and self-awareness: On the nature of the relation. *The Journal of Mind and Behavior*, **14**, 223–234.
- Morin, A. (1995). Characteristics of an effective internal dialogue in the acquisition of self-information. *Imagination, Cognition and Personality*, **15**, 45–58.
- Morin, A. (2002). Right hemispheric self-awareness: A critical assessment. *Consciousness and Cognition*, **11**, 396–401.
- Morin, A. (2004). A neurocognitive and socioecological model of self-awareness. *Genetic, Social, and General Psychology Monographs*, **130**, 197–222.
- Morin, A. (2005). Possible links between self-awareness and inner speech: Theoretical background, underlying mechanisms, and empirical evidence. *Journal of Consciousness Studies*, **12**, 115–134.
- Morin, A. (2007). Self-awareness and the left hemisphere: The dark side of selectively reviewing the literature. *Cortex*, **8**, 1068–1073.
- Morin, A. (2009a). Inner speech: A neglected phenomenon. *Psychoscience*.
- Morin, A. (2009b). Self-awareness deficits following loss of inner speech: Dr. Jill Bolte Taylor's case study. *Consciousness and Cognition*, **18**, 524–529.
- Morin, A. (2010). Self-recognition, Theory-of-Mind, and self-awareness: What side are you on? *Laterality*, **16**, 367–383.
- Morin, A. (2011). Self-awareness Part 1: Definitions, measures, effects, function, and antecedents. *Social and Personality Psychology Compass*, **5**, 807–823.
- Morin, A. (forthcoming). Inner speech. In W. Hirstein (Ed.), *Encyclopedia of Human Behavior*, Second edition. Elsevier.
- Morin, A., Everett, J., Turcotte, I., & Tardif, G. (1993). Le dialogue intérieur comme médiateur cognitif de la conscience de soi privée: Une mesure de l'activité de se parler à soi-même à propos de soi et une étude [Self-talk as a mediator of private self-consciousness: A measure of the activity to talk to oneself about oneself and a correlational study]. *La Revue Québécoise de Psychologie*, **14**, 3–19.
- Morin, A., & Hamper, B. (forthcoming). Self-reflection and the inner voice: Differential activation of Broca's area across self-domains during self-referential thinking. Submitted for publication.
- Morin, A., & Michaud, J. (2007). Self-awareness and the left inferior frontal gyrus: Inner speech use during self-related processing. *Brain Research Bulletin*, **74**, 387–396.
- Morin, A., Uttl, B., & Hamper, B. (forthcoming). Self-reported frequency, content, and functions of inner speech in college students. *Procedia – Social and Behavioral Journal*.
- Moss, C. V. (1972). *Recovery with Aphasia*. Urbana: University of Illinois Press.
- Neuman, Y., & Nave, O. (2010). Why the brain needs language in order to be self-conscious. *New Ideas in Psychology*, **28**, 37–48.
- Newton, A. M., & de Villiers, J. G. (2007). Thinking while talking: Adults fail nonverbal false-belief reasoning. *Psychological Science*, **18**, 574–579.
- Northoff, G., Heinzl, A., de Greck, M., Bermpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain: A meta-analysis of imaging studies on the self. *NeuroImage*, **31**, 440–457.
- Ojemann, G. (1986). Brain mechanisms for consciousness and conscious experience. *Canadian Psychology/Psychologie Canadienne*, **27**, 158–168.
- Phan, K. L., Wager, T. D., Taylor, S. F., & Liberzon, I. (2004). Functional neuroimaging studies of human emotions. *CNS Spectrums*, **9**, 258–266.
- Platek, S. M., Keenan, J. P., Gallup, G. G., Jr., & Mohamed, F. B. (2004). Where am I? The neurological correlates of self and other. *Cognitive Brain Research*, **19**, 114–122.
- Platek, S. M., Wathne, K., Tierney, N. G., & Thomson, J. W. (2008). Neural correlates of self-face recognition: An effect-location meta-analysis. *Brain Research*, **1232**, 173–184.
- Plotnik, J. M., de Waal, F. B. M., & Reiss, D. (2006). Self-recognition in an Asian elephant. *Proceedings of the National Academy of Sciences of the United States of America*, **103**, 17053–17057.
- Povinelli, D. J. (1995). The unduplicated self. In P. Rochat (Ed.), *The Self in Early Infancy* (pp. 161–192). Amsterdam: North-Holland-Elsevier.
- Preilowski, B. (1977). Self-recognition as a test of consciousness in left and right hemisphere of “split-brain” patients. *Acta Psychologica*, **19** (Suppl.), 343–344.
- Prior, H., Schwartz, A., & Gunturkun, O. (2008). Mirror-induced behaviour in the magpie (*Pica pica*): Evidence of self-recognition. *PLoS Biology*, **6**, e202. doi: 10.1371/journal.pbio.0060202.
- Reiss, D., & Marino, L. (2001). Mirror self-recognition in the bottlenose dolphin: A case of cognitive convergence. *Proceedings of the National Academy of Sciences of the United States of America*, **98**, 5937–5942.
- Roberts, R. N. (1979). Private speech in academic problem-solving: A naturalistic perspective. In G. Zivin (Ed.), *The Development of Self-Regulation through Private Speech* (pp. 295–324). New York: Wiley.

- Rosa, C., Lassonde, M., Pinard, C., Keenan, J. P., & Belin, P. (2008). Investigations of hemispheric specialization of self-voice recognition. *Brain and Cognition*, **68**, 204–214.
- Rusalova, M. N. (2005). Characteristics of interhemisphere interactions at different levels of consciousness. *Neuroscience and Behavioral Physiology*, **35**, 821–827.
- Salmon, E., D'Argembeau, A., Bastin, C., Feyers, D., Phillips, C., Laureys, S. et al. (2008). Brain imaging of reflection on self. *Revue Medicale de Liege*, **63**, 458–460.
- Schilbach, L., Eickhoff, S. B., Rotarska-Jagiela, A., Fink, G. R., & Vogeley, K. (2008). Minds at rest? Social cognition as the default mode of cognizing and its putative relationship to the “default system” of the brain. *Consciousness and Cognition*, **17**, 457–467.
- Schneider, J. F. (2002). Relations among self-talk, self-consciousness, and self-knowledge. *Psychological Reports*, **91**, 807–812.
- Schneider, J. F., Pospeschill, M., & Ranger, J. (2005). Self-consciousness as a mediator between self-talk and self-knowledge. *Psychological Reports*, **96**, 387–396.
- Siegrist, M. (1995). Inner speech as a cognitive process mediating self-consciousness and inhibiting self-deception. *Psychological Reports*, **76**, 259–265.
- Silani, G., Bird, G., Brindley, R., Singer, T., Frith, C., & Frith, U. (2008). Levels of emotional awareness and autism: An fMRI study. *Social Neuroscience*, **3**, 97–112.
- Sokolov, A. N. (1972). *Inner Speech and Thought*. New York: Plenum Press.
- Sperry, R., Zaidel, E., & Zaidel, D. (1979). Self-recognition and social awareness in the disconnected minor hemisphere. *Neuropsychologia*, **17**, 153–166.
- Stamenov, M. (2003). Language and self-consciousness: Modes of self-presentation in language structure. In T. Kircher & A. David (Eds.), *The Self in Neuroscience and Psychiatry* (pp. 76–104). Cambridge, UK: Cambridge University Press.
- Svoboda, E., McKinnon, M. C., & Levine, B. (2006). The functional neuroanatomy of autobiographical memory: A meta-analysis. *Neuropsychologia*, **44**, 2189–2208.
- Taylor, J. B. (2006). *My Stroke of Insight: A Brain Scientist's Personal Journey*. New York: Viking.
- Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the Five-Factor Model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology*, **76**, 284–304.
- Tullett, A. M., & Inzlicht, M. (2010). The voice of self-control: Blocking the inner voice increases impulsive responding. *Acta Psychologica*, **135**, 252–256.
- Turk, D. J., Heatherton, T. F., Kelley, W. M., Funnell, M. G., Gazzaniga, M. S., & Macrae, C. N. (2002). Mike or me? Self-recognition in a split-brain patient. *National Neuroscience*, **5**, 841–842.
- Turk, D. J., Heatherton, T. F., Macrae, C. N., Kelley, W. M., & Gazzaniga, M. S. (2003). Out of contact, out of mind: The distributed nature of the self. *Annals of the New York Academy of Science*, **1001**, 1–14.
- Uddin, L. Q., Rayman, J., & Zaidel, E. (2005). Split-brain reveals separate but equal self-recognition in the two cerebral hemispheres. *Consciousness and Cognition*, **14**, 633–640.
- Van der Meer, L., Costafreda, S., Aleman, A., & David, A. S. (2010). Self-reflection and the brain: A theoretical review and meta-analysis of neuroimaging studies with implications for schizophrenia. *Neuroscience and Biobehavioral Reviews*, **34**, 935–946.
- Van Overwalle, F. (2011). A dissociation between social mentalizing and general reasoning. *Neuroimage*, **54**, 1589–1599.
- Verstichel, P., Bourak, C., Font, V., & Crochet, G. (1997). Langage intérieur après lésion cérébrale gauche: Etude de la représentation phonologique des mots chez des patients aphasiques et non aphasiques [Inner speech and left brain damage: Study of the phonological analysis of words in aphasic and non-aphasic patients]. *Revue de Neuropsychologie*, **7**, 281–311.
- Vygotsky, L. S. (1943/1962). *Thought and Language*. Cambridge: MIT Press.
- Werning, M. (2010). Descartes discarded? Introspective self-awareness and the problems of transparency and compositionality. *Consciousness and Cognition*, **19**, 751–761.
- Whitehouse, A. J. O., Mayberry, M. T., & Durkin, K. (2006). *Inner speech impairments in autism*. *Journal of Child Psychology and Psychiatry*, **47**, 857–866.
- Wickera, B., Ruby, P., Royet, J. P., & Fonlupt, P. (2003). A relation between rest and the self in the brain? *Brain Research Reviews*, **43**, 224–230.
- Williams, D. (2010). Theory of own mind in autism: Evidence of a specific deficit in self-awareness? *Autism*, **14**, 474–494.
- Winsler, A. (2009). Still talking to ourselves after all these years: A review of current research on private speech. In A. Winsler, C. Fernyhough & I. Montero (Eds.), *Private Speech, Executive Functioning, and the Development of Verbal Self-Regulation* (pp. 3–41). New York: Cambridge University Press.
- Winsler, A., Abar, B., Feder, M., Rubio, D. A., & Schunn, C. (2007). Private speech and executive functioning among high functioning children with autistic spectrum disorders. *Journal of Autism and Developmental Disabilities*, **37**, 1617–1635.
- Zelazo, P. D. (2004). The development of conscious control in childhood. *Trends in Cognitive Sciences*, **8**, 12–17.
- Zivin, G. (1979). Removing common confusions about egocentric speech, private speech, and self-regulation. In G. Zivin (Ed.), *The Development of Self-Regulation through Private Speech* (pp. 13–50). New York: Wiley.