

# Self-awareness Part 1: Definition, measures, effects, functions, and antecedents

Alain MORIN

Department of Psychology, Mount Royal University

Self-awareness represents the capacity of becoming the object of one's own attention. In this state one actively identifies, processes, and stores information about the self. This paper surveys the self-awareness literature by emphasizing definition issues, measurement techniques, effects and functions of self-attention, and antecedents of self-awareness. Key self-related concepts (e.g., minimal, reflective consciousness) are distinguished from the central notion of self-awareness. Reviewed measures include questionnaires, implicit tasks, and self-recognition. Main effects and functions of self-attention consist in self-evaluation, escape from the self, amplification of one's subjective experience, increased self-knowledge, self-regulation, and inferences about others' mental states (Theory-of-Mind). A neurocognitive and socioecological model of self-awareness is described in which the role of face-to-face interactions, reflected appraisals, mirrors, media, inner speech, imagery, autobiographical knowledge, and neurological structures is underlined.

## Introduction

This article (Part 1 of two papers) explores the “how”, “why”, and “when” of self-awareness. In doing so it seeks to provide the reader with an overview of the most fundamental questions in this research area. *How* do our brain, cognitive processes, and social environment give rise to self-awareness? *Why* are we self-aware—what functions does self-reflection serve? And *when*, in what situations, are we most likely to engage in self-observation? Another topic that will be examined is measurement issues. Note that Part 2 of this article will focus on *where* self-awareness is located in the brain and will address the question of the importance of inner speech in self-referential processing.

## Consciousness and self-awareness

It is imperative to start with clear definitions of key terms, as confusion between “consciousness”, “self-awareness”, and a host of related expressions is rampant in the literature (Antony 2001, 2002). The sociologist George Herbert Mead (1934) proposed a classic distinction between focusing attention outward toward the environment (consciousness), and inward toward the self (self-awareness). When “conscious”, an organism can successfully process incoming information from the environment and respond to it adaptively (Natsoulas 1996). Under this definition, most, if not all non-human animals are conscious (e.g., Edelman & Seth 2009; Morin 2011). Unconsciousness signifies the absence of processing of information either from the environment or the self, such as during sleep or coma. Various levels of consciousness have been identified (see Morin 2006). Terms such as “primary”, “peripheral”, “sensorimotor”, and “core” consciousness designate more or less sophisticated degrees of consciousness. For example, Zelazo (2004) uses the term “minimal consciousness” to describe the infant's unreflective experience of stimuli in the present, and Neisser (1997) labels “interpersonal self” the raw awareness of one's engagement in social interactions here and now, allowing one's actions to mesh with those of others.

Self-awareness refers to the capacity of becoming the object of one's own attention (Duval & Wicklund 1972). In this state one actively identifies, processes, and stores information about the self. The important distinction here is as follows: One can perceive and process stimuli from the environment (e.g., a colour, food) without explicitly knowing that one is doing so (consciousness). One becomes self-aware when one *reflects* on the experience of perceiving and processing stimuli (e.g., I see a blue object; I am eating food and it tastes good). Self-awareness represents a complex multidimensional phenomenon that comprises various self-domains and corollaries. To illustrate, one can think about one's past (autobiography) and future (prospaction). Similarly, one can focus on one's emotions, thoughts, personality traits, preferences, goals, attitudes, perceptions, sensations, intentions, and so forth. The list of potentially relevant self-aspects is very long indeed (see Ben-Artzi, Mikulincer & Glabman 1995). Emotions or traits are private self-aspects that can be distinguished from public self-dimensions—visible characteristics such as one's body, physical appearance, mannerisms, and behaviors (Fenigstein 1987). Examples of self-awareness corollaries are sense of agency, Theory-of-Mind (ToM; making inferences about others' mental states), self-description, self-evaluation, self-esteem, self-regulation, self-efficacy, death awareness, self-conscious emotions, self-recognition, and self-talk (Morin, Uttl & Hamper 2011). Some of these consequences of self-focused attention will be examined below. Self-awareness also entails a sense of continuity as a person across time and includes a feeling of self as being distinct from the rest of the environment

(Kircher & David 2003). Self-awareness also comes in degrees: Terms such as “meta”, “reflective”, “iterative meta-representational”, and “extended” consciousness indicate various levels of self-awareness (Morin 2006; also see Legrain, Cleeremans & Destrebecqz 2010). To illustrate, Newen and Vogeley (2003) distinguish between “conceptual self-consciousness”, where the organism can conceptually represent itself, including its mental states, and “meta-representational self-consciousness”, which consists in constructing a mental model of oneself and of other people (ToM), and includes access to autobiographical knowledge. Thus whereas conceptual self-consciousness uniquely pertains to the self and its mental experiences, meta-representational self-consciousness also explicitly includes self-memories and inferences about others's experiences. The ultimate level of consciousness is meta-self-awareness—being aware that one is self-aware (Morin & Everett 1990). Table 1 summarizes the analysis presented in this section.

Levels	Definition
1- Unconsciousness	Being non-responsive to self & environment.
2- Consciousness	Focusing attention on the environment; processing incoming external stimuli.
3- Self-awareness	Focusing attention on the self; processing private & public self-information.
4- Meta-self-awareness	Being aware that one is self-aware.

Table 1: Four levels of consciousness

### Measures and manipulations of self-awareness

Before 1972 most research conducted on self-awareness was phenomenological in nature (Rimé & LeBon 1984). The publication of Duval and Wicklund's book that year marked the beginning of the empirical study of self-focused attention. This team showed that a state of self-awareness could be experimentally induced by exposing participants to self-focusing stimuli. Stimuli such as mirrors, cameras, an audience, and recordings of one's voice are known to remind the person of his or her object status to others and reliably produce heightened self-awareness (Carver & Scheier 1978; Davis & Brock 1975; Geller & Shaver 1976). Small mirrors generate an awareness of more private aspects of the self, whereas large mirrors and audiences induce public self-scrutiny (Buss 1980; Davies 2005).

Numerous self-report instruments have been developed to assess dispositional self-focus. The Self-Consciousness Scale (SCS) was the first such questionnaire to be designed (Fenigstein, Scheier & Buss 1975). Psychometric evidence (e.g., test-retest reliability) suggests that self-consciousness is stable enough to be viewed as a personality trait (Davis & Franzoi 1991). The SCS consists in three sub-scales: Private and public self-consciousness, and social anxiety (Carver & Glass 1976; Turner et al. 1978). Many different versions of the SCS have since been created (e.g., Burnkrant & Page 1984; Grant, Franklin & Langford 2002) and translated in various languages (e.g., Bendaria & Abed 1997). In 1990 Trapnell and Campbell reassessed the psychometric characteristics of the SCS and showed that the private self-consciousness sub-scale actually measures two different constructs: Self-reflection and self-rumination (see Morin 2002). Self-reflection represents a genuine curiosity about the self, where the person is intrigued and interested in learning more about his or her emotions, values, thought processes, attitudes, etc. This type of introspection mostly leads to positive consequences associated with good mental health, such as self-knowledge and self-regulation. Self-rumination is anxious attention paid to the self, where the person is afraid to fail and keeps wondering about his or her self-worth. It generally produces more negative consequences linked to psychological dysfunctions such as anxiety and depression (Joireman 2004; Joireman, Parrott & Hammersla 2002). Excessive ruminative self-focus creates worry, guilt, shame, jealousy, insomnia, etc. (Leary 2004), and may contribute to social anxiety (Buss 1980) and depression (Mor & Winquist 2002). Psychologically unhealthy individuals are known to self-ruminate (Smith & Alloy 2009).

Spontaneously occurring fluctuations in self-awareness can be measured with the Situational Self-Awareness Scale (Govern & Marsch 2001). Any social environment that emphasizes a person's unique characteristics (e.g., being the only female in a group of males) leads to individuation and temporarily enhances self-focus (Phemister & Crewe 2004). A social context that encourages similarity in behavior, appearance, and values (e.g., the army) instead produces deindividuation and decreases self-focus (Diener 1979; Wicklund 1975).

First-person singular pronouns use in written documents reflects increased self-awareness because pronouns such as “me”, “myself”, and “mine” indicate that the person is thinking about the self (Davis & Brock 1975). Schaller (1997) showed that celebrities use significantly more first-person singular pronouns in their songs or books following the attainment of fame. Wegner and Giuliano (1980) developed the Linguistic Implications Form, where participants are invited to complete ambiguous sentences by selecting the pronouns that seem to fit best. The ratio of first- and third-person pronouns use is then calculated as an index of self-awareness.

Health professionals often evaluate patients' awareness of their deficits (e.g., after brain injury) by quantifying the match between self- and other-ratings on cognitive, social, and emotional functioning (Cocchini et al. 2009); a low match suggests self-awareness impairment. This measure can also be applied to assess self-knowledge in healthy individuals (Hoerold et al. 2008). Silvia and Eichstaedt (2004) designed a Self-Novelty Manipulation where participants are asked to write about ways in which they differ from others; thinking about what makes one unique induces self-attention. The Word-Recognition Measure (Eichstaedt & Silvia 2003) asks subjects to identify self-relevant or self-irrelevant words as quickly as possible. Self-aware individuals identify self-relevant words faster than non self-aware individuals. One last measure of self-awareness is facial self-recognition (see Gallup 1968; Gallup, Anderson & Shillito 2002), which will be discussed in Part 2 of this review. Table 2 below summarizes the above discussion pertaining to the assessment and manipulation of self-awareness.

It is noteworthy that with the exception of facial recognition, all existing measures of self-awareness entail some form of verbal processing or production. The empirical study of self-awareness in non-verbal organisms (e.g., infants and non-human animals) ends up being severely impeded by this state of affairs. Non-linguistic measures of metacognition in animals have been used (e.g., uncertainty responses during perceptual or memory tasks—see Smith 2009), but because so many non-mentalistic accounts of animals' performance on these measures are available, it remains difficult to conclude that they indeed assess metacognition *per se*—and thus self-awareness (Carruthers 2008). Furthermore, employing an inner speech suppression condition to evaluate the role of language during self-referential processing would be highly problematic if a *verbal* measure of self-awareness were to be used: Would the anticipated performance deterioration caused by the fact that subvocal speech is required for the processing of self-relevant information, or because participants in the suppression condition can't process the linguistic information inherent to the task?

Measure	Description
Self-focusing stimuli (mirrors, cameras, audience, voice recording) (Duval & Wicklund 1972).	Remind people of their object status & induce self-observation.
Self-Consciousness Scale (Fenigstein et al. 1975).	Assesses individual differences in the time spend focusing on private/public self-aspects & social anxiety.
Self-reflection / Self-rumination scales (Trapnell & Campbell 1990).	Quantify positive & negative forms of private self-focus.
Situational Self-Awareness Scale (Govern & Marsch 2001).	Measures spontaneously occurring fluctuations in self-awareness.
Linguistic Implications Form (Wegner & Giuliano 1980).	First-person pronouns use indicates self-focus because “me”, “myself” & “mine” equate self-thinking.
Match between self- and other-ratings on cognitive, social, & emotional functioning (Cocchini et al. 2009).	A match indicates intact self-knowledge – & thus healthy self-reflection.
Self-Novelty Manipulation (Silvia & Eichstaedt 2004). Participants are asked to write about ways in which they differ from others.	Thinking about what makes one unique induces self-attention.
Word-Recognition Measure (Eichstaedt & Silvia 2003). Subjects are asked to identify self-relevant or self-irrelevant words as quickly as possible.	Increased self-focus facilitates recognition of self-relevant words.
Self-recognition (Gallup 1968).	Recognizing one's face in a mirror or on a photograph indicates self-awareness.

Table 2: Main self-awareness measurement tools and manipulations

### Effects and functions of self-attention—Self-evaluation

Research conducted these last 40 years with the aforementioned manipulations and measures suggests that heightened self-focus produces a host of effects (for reviews see Carver 2002; Silvia & Duval 2001; Wicklund 1975, 1978). Inducing self-awareness with self-focusing stimuli leads to self-evaluation (Duval & Wicklund 1972), whereby the person compares any given salient self-aspect to an ideal representation of it. Self-criticism is then likely to occur, leading to an avoidance of the state of self-awareness or a reduction of the real self—ideal self discrepancy, by either modifying the target self-aspect or by changing the ideal itself. Figure 1 schematically illustrates the self-evaluation process. Note that *positive* discrepancies can exist (e.g., following a success experience), in which case a person will actually *seek* the state of self-awareness. Representative research shows that participants with salient self-related discrepancies (e.g., an induced attitude-behavior inconsistency) will be reluctant to sit in front of a mirror, whereas subjects with consistent attitudes won't (Greenberg & Musham 1981). Children will less frequently transgress a standard (e.g., the experimenter's instructions to take only one candy on Halloween) and college students will cheat less often on a bogus IQ test when in front of a mirror (Beaman et al. 1979).

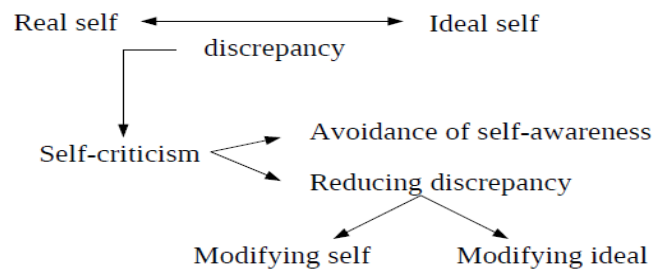


Figure 1: The self-evaluation process

More recent work conducted by Silvia and Duval (2001) further qualifies the self-evaluation process outlined above. Figure 2 depicts the revised process. The larger the discrepancy the stronger the need to avoid self-awareness as opposed to reducing the discrepancy, and vice-versa. Positive outcome expectancy and high rate of progress increase the likelihood of changing the self as opposed to escaping it, and vice-versa for negative outcome expectancy and low rate of progress. Self-aware individuals who focus on the real self will attribute the cause of the discrepancy to the real self and will try to change it. Paying attention to the standard instead motivates people to attribute the cause of the discrepancy to the standard, and that standard (as opposed to the real self) will be modified.

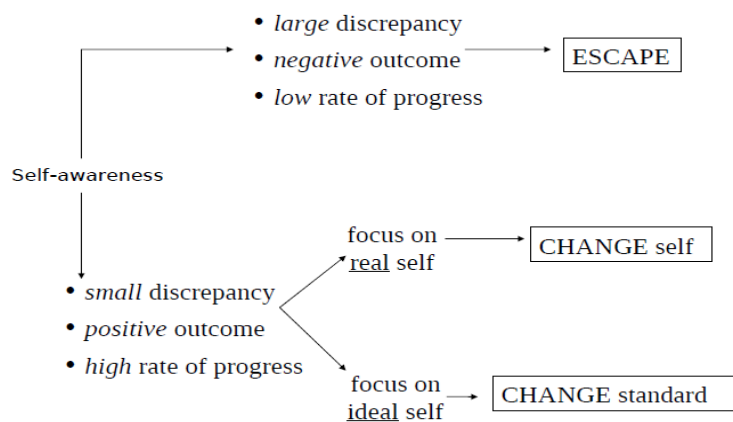


Figure 2: The revised self-evaluation process

### Escaping the self

Self-awareness avoidance may take many forms. One of the most frequent form of escape from the self is watching television. Moskalkenko and Heine (2003) measured the amount of time participants watched television after receiving the result of a sham IQ test. To create a self-discrepancy to motivate participants to avoid self-awareness, the team told some participants that they did very poorly on the IQ test. Other participants receive a positive feedback or no feedback at all. During a 6-minute period in which television was available after test scores were disclosed, subjects who got back good scores (no discrepancy) were observed watching TV only 2.5 minutes on average. Those who received no feedback on their score watched TV for about three minutes, and participants who were told that they had low IQ scores (discrepancy) turned to TV an average of more than four minutes.

People also escape the self by drinking alcohol, taking drugs, overeating, engaging in extreme sexual behavior, and ultimately committing suicide (Baumeister 1990, 1991; Hull 1981). Indeed, people who experience real self – ideal self discrepancies (e.g., failing to attain important standards) report an increased accessibility to suicide-related thoughts (Chatard & Selimbegović 2011). Schaller (1997) proposed that famous people experience chronic self-focus and may resort to extreme strategies in order to reduce negative emotions caused by chronic self-observation, namely, drug and alcohol abuse, or even suicide. Schaller (1997) conducted three single-case (historiometric) quantitative analyses in which he produced biographical outlines of famous persons known for their self-destructive behaviors: Songwriters Kurt Cobain (who committed suicide in 1993) and Cole Porter (1891-1964—Porter was an alcoholic), and writer John Cheever (1912-1982—also an alcoholic). Schaller measured self-

awareness by calculating the number of first-person singular pronouns found in the songs, short stories or personal letters of these three celebrities. Using biographies, he then determined the exact moment these individuals attained fame and also measured Cheever's self-reported alcohol consumption by analyzing his personal letters. As predicted, the onset of fame induced high self-focus. In other words, Cobain, Porter, and Cheever began to use significantly more first-person singular pronouns in songs, stories and personal letters following their brush with fame. Also, this onset was significantly related (in Cheever's case) to higher self-reported alcohol use.

Morin and Craig (2000) expanded these results with one additional case-study: Nobel Prize winner Ernest Hemingway—a well-known heavy drinker who committed suicide in 1961 (see Burgess 1978). The team analyzed Hemingway's writings and personal letters, and showed that there was a significant increase in self-awareness following fame in 1929 when *A Farewell to Arms* was published. Morin and Craig (2000) also assessed self-awareness (with the SCS) and self-reported alcohol use in relatively well-known and not well-known students and faculty members in a Canadian university. Self-focus and alcohol use were significantly higher in the group of well-known participants (e.g., Deans, Chairs, and Heads of programs).

### **Increased emotional intensity**

Another effect of self-awareness is emotional intensity: Focusing on one's emotions or physiological responses amplifies one's subjective experience (Carver & Scheier 1981). To illustrate, angry self-aware individuals will behave more aggressively than non self-aware participants when provoked by the experimenter (Scheier 1976). Self-focused males will rate pictures of naked females significantly more positively than non-self-aware males (Scheier & Carver 1977). Silvia (2002) however suggests that the amplification effect exclusively applies to emotions resulting from self-discrepancies—a more intense joy following a success experience and a more painful disappointment caused by failure. In addition, negative emotions resulting from social rejection are avoided through self-awareness escape, which leads to emotional lethargy instead of amplification. (Twenge, Catanese & Baumeister 2003).

### **Self-knowledge**

Self-awareness also increases accurate access to one's self-concept (Gibbons 1983; Markus 1983). Self-reports of self-aware individuals are more accurate (Pryor et al. 1977; Turner 1978). Subjects being chronically attentive to public self-aspects will give a faster evaluation of their physical characteristics when compared with low publicly self-conscious subjects, and will be judged by others as being more attractive, presumably because they are more concerned and careful about the way they present themselves (Turner, Gilliland & Klein 1981). Self-focused subjects who will be given a placebo with the anticipation of symptoms of arousal will report experiencing significantly *less* symptoms than controls (Gibbons et al. 1979). In short, it seems that self-aware individuals know themselves better (Turner 1976)—although this conclusion has been questioned on conceptual grounds by Silvia and Gendolla (2001). To illustrate, it remains possible that better self-report accuracy following self-focus be the result of an heightened consistency motivation or the activation of honesty standards as opposed to plain better introspection. Other effects or consequences of self-awareness are increased consistency between one's behavior and attitudes (Gibbons 1978), reduction of the self-serving bias (e.g., tendency to attribute failure internally) provided that a probability for improvement exists (Duval & Silvia 2002), increased self-disclosure in intimate relationships (Davis & Franzoi 1986), stronger reaction to social rejection (Fenigstein 1979), and a decrease in social conformity and in antinormative behaviour (Diener & Wallbau 1976).

### **Self-regulation**

Overall, our ability to self-reflect facilitates a smooth navigation in our social environment and thus increases the likelihood of survival (Leary 2004). More specifically, one major adaptive function of self-awareness is self-regulation, which includes altering one's behavior, resisting temptation, changing one's mood, selecting a response from various options, and filtering irrelevant information (Baumeister & Vohs 2003). Self-regulation involves a self-evaluative process described above, itself dependent upon self-awareness. In essence, one must be cognizant of what self-aspects need to be modified before effective cognitive-behavioral control can occur (Mikulas 1986). Carver and Scheier (1981, 1982; Carver 1979; Scheier & Carver 1988) proposed a comprehensive model of self-regulation based on self-attention. Current work in this area indicates that self-regulation consumes an energy that is depleted afterward. When people dominate their responses, they are later less successful at controlling themselves. Some resource similar to strength is exhausted during self-regulation, which creates a state called "ego depletion" (Baumeister & Vohs 2007; Baumeister et al. 1998). Positive affect helps improve self-regulation following ego depletion (Tice et al. 2007). Private speech use in children has been shown to be positively

correlated with effective self-regulation (e.g., Meichenbaum 1976; Vygotsky 1943/1962; Winsler 2009). There is recent evidence that the link between self-talk and self-regulation also applies to adults and is causal—not just correlational. Tullett and Inzlicht (2010) suppressed participants' inner speech and observed greater impulsivity on a Go/No Go task.

### **Theory-of-mind**

Self-awareness is also related to our ability to engage in Theory-of-Mind (ToM), which constitutes a fundamental component of social cognition (Malle 2005). ToM represents the ability to attribute mental states such as goals, intentions, beliefs, desires, thoughts, and feelings to others (Gallagher & Frith 2003). The benefits of ToM are the possibility of predicting others' behavior and, on that basis, helping, avoiding, or deceiving others as the situation dictates. A full development of ToM occurs at around 6 years of age; this development seems to be related to language acquisition (Garfield, Peterson & Perry 2001; Milligan, Astington & Dack 2007) and triadic interactions (Carpendale & Lewis 2004). ToM deficits have been observed in autism (Baron-Cohen 2001) and schizophrenia (Brune 2005). These deficits are increasingly being associated with brain dysfunction, most probably located in the more anterior region of the dorsal medial prefrontal cortex (Amodio & Frith 2006). The links between ToM and self-awareness are complex and still poorly understood (Williams 2010; for a review see Dimaggio et al. 2008). Common brain areas are recruited when we both introspect and think about others' mental states (Rameson & Lieberman 2009). Some argue that ToM development (thinking about others' mental states) precedes self-awareness growth (thinking about one's own mental states; Carruthers 2009). In this perspective, self-reflection would constitute a by-product of ToM. However, the most popular hypothesis (the Simulation / Projection view) suggests that self-awareness comes first and is then followed by a natural tendency to impute internal states to others through a form of mental simulation or projection (e.g., Gallup 1982; Keenan, Gallup & Falk 2003). Studies show that better self-reflection abilities are associated with better ToM skills (Lysaker et al. 2007). In addition, improving self-awareness skills in clinical populations (e.g., schizophrenia) may lead to more sophisticated ToM abilities (Lysaker & Hermans 2007). A variation of the Simulation view states that once fully developed, TOM stops directly involving self-awareness and takes a life of its own (Morin 2003). That is, one most likely first needs to be aware of one's own mental states in order to conceive that other persons may be experiencing comparable processes. Once one knows that other persons probably experience mental events like one does, there is no need anymore to constantly self-reflect in order to better understand these mental experiences.

### **A neurocognitive and socioecological model of self-awareness**

Above and beyond definitions, measures, effects, and functions, one must ask: What are the underlying mechanisms that explain the emergence and maintenance of self-awareness? How can one organize most known information about self-awareness into a coherent global system? Various models of self-reflection have been proposed (e.g., Burns & Engdahl 1998a, 1998b; Feinberg 2010b; Mischel & Morf 2002; Rochat 2010; Stuss, Picton & Alexander 2001). However, these models tend to exclusively address isolated neurological or social factors involved in self-awareness. Morin (2004) put forward a more comprehensive neurocognitive and socioecological model which considers brain regions, environmental and social influences, and cognitive processes that lead to self-awareness.

Figure 3 shows three main sources of self-awareness: The social milieu (1), the physical world (2), and the self (3). Italic numbers and capital letters in the text below refer to elements of the model in Figure 3. Solid lines join the two first sources of self-awareness to the self, as well as the self to itself. The social environment contains early face-to-face communication (1.1), self-relevant feedback that the individual gets from other persons (reflected appraisals [1.2]), a social comparison mechanism that initiates perspective taking (1.3), and the presence of other individuals observing the self (audiences [1.4]). The physical environment consists in objects and structures that produce bodily awareness and self-world differentiation in infants (2.1), self-focusing and reflecting stimuli (2.2), and written material printed in books, articles, and numerous media sources (2.3). The self can further develop bodily awareness with proprioception (3.2) and can reflect on itself by engaging in cognitive processes such as inner speech (3.3) and imagery (3.4). Self-awareness also requires the activation of specific brain structures (3.1) as well as autobiographical information (3.5). Broken lines in Figure 3 correspond to various links (e.g., A, B, C...) that can be drawn between all these sources of self-information. Table 3 summarizes the links proposed by the model. Note that the neuroanatomy of self-awareness (3.1) and the role played by inner speech (3.3) will be examined in Part 2 of this review.

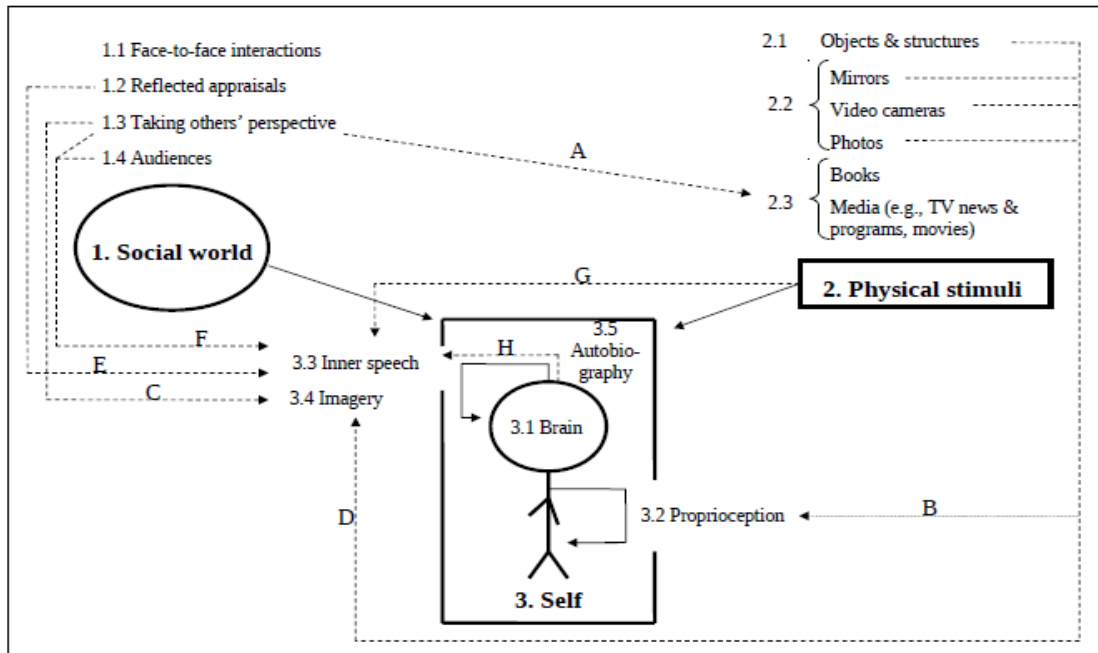


Figure 3: A neurocognitive and socioecological model of self-awareness

A: Physical stimuli (2.2) extend perspective-taking (1.2).
B: Self-reflecting devices (2.1) participate in the formation of body awareness (3.2).
C: Imagery (3.4) can internally reproduce social mechanisms (1.2, 1.3) responsible for self-awareness.
D: Experiences with self-reflecting devices (2.1) are crucial in acquiring autoscopic imagery (3.4).
E: Inner speech (3.3) can reproduce social feedback (1.1).
F: Inner speech (3.3) can internalize others' perspective (1.2).
G: Self-talk (3.3) is activated when one is exposed to self-reflecting devices (2.1).
H: Inner speech (3.3) is activated when brain areas known to sustain self-awareness (3.1) get activated.

Table 3: Various links proposed by the model

### Social world (1)

The role of early nonverbal social communication (1.1) between the infant and the caregiver in self–other differentiation has been extensively studied (e.g., Butterworth 1992, 1995; Legerstee 1999; Neisser 1997; Rochat 2003). Infants and caregivers repeatedly engage in face-to-face interactions during which both participants react to one another by smiling and vocalizing. The infant's behavior motivates responses from the caregiver, with the baby responding in turn, and so forth. This leads to an understanding that the self can produce effects in the environment and that it represents a unique and independent entity. Imitation is important in that respect. The infant imitates tongue protrusion, mouth opening, lip pursing, sequential finger movements, blinking, vocalization, gestures, and emotional expressions. Perceiving the match between self and other informs the self about itself (Butterworth 1995). The development of bodily awareness is also facilitated by frequent physical contact between infant and caregiver.

Cooley (1902) proposed that people often comment on one's personality characteristics and behaviors. These reflected appraisals (1.2) are informative to the self and can also induce self-focus. Mead (1934; also see Natsoulas 1985) suggested that comparisons with others motivate individuals to take others' perspectives to gain an objective point of view on themselves (1.3). Once in this stance, individuals become self-aware and can acquire information about the self.

As discussed earlier, being in front of an audience (1.4) creates self-focus (Diener 1979; Diener et al. 1980). For instance, participants scored significantly higher on a measure of egocentrism when in front of an audience than when alone (Carver & Scheier 1978). Being observed by only one person is enough to produce self-awareness (Buss 1980). Representative examples include giving a speech in front of a class, being the target of attention as one enters a room full of people, or being observed by one's boss at work.

### Physical world (2)

Bermudez (1998, 1999) argues that visual perception and physical interactions with objects foster self-world differentiation (2.1; also see Butterworth 1992, 1995; Legerstee 1999; Neisser 1997). Visual kinesthesia simultaneously involves self-perception and world perception. The self appears in vision as the boundary of the visual field; likewise, the patterns of flow in the optic display and the relationships between the changing and stable qualities of the physical environment allow the perceiver to learn about his or her own movements. In addition, lateral displacement, rotation, and movement against a background, as well as contacts with objects and people (e.g., touching, squeezing, rubbing, sucking, throwing, kicking), make it possible for the infant to further develop a kinesthetic sense of self.

As seen previously, the physical environment contains self-focusing stimuli that induce self-attention (2.2). These stimuli can also be seen as self-reflecting objects. One can acquire key information about one's facial features and expressions, mannerisms, tone of voice, body height and weight, skin tone and complexion, hairstyle, etc. by observing oneself in the mirror or seeing oneself on video. These public characteristics are important because they at least partially define one's personal identity (Cole 1999). Another type of physical stimuli that can produce self-focus is written material found in books and articles, the media (newspapers and television news and programs), the Internet, radio, CDs, and movies, including videotapes and DVDs (2.3; see Link A in Figure 3). These stimuli convey a host of views and behaviors (and, indirectly, underlying motives, values, attitudes, emotions, etc.) that are potentially different from one's own present beliefs and actions. Being exposed to different ideas or emotions (e.g., a journalist's appraisal of a given event) is likely to elicit perspective taking and self-awareness (e.g., how do *I* assess this event?).

### The self (3)

The self can become the object of its own attention and reflect on itself (Duval & Wicklund 1972). It thus becomes a precious source of self-information to which it has privileged access. The baby's body constantly experiences various states of pressure and temperature, friction from skin receptors, balance and posture from joints, muscles, and the vestibular system (Eilan, Marcel & Bermudez 1995). These experiences all facilitate the development of somatic proprioception (3.2). Double sensory stimulation also provides information about the body: When infants touch themselves, they simultaneously feel that they touch and are being touched. Link B in Figure 3 suggests that self-reflecting devices present in one's environment (2.2) also play a role in the formation of body awareness. Repeatedly perceiving oneself in the mirror, on video camera, or in pictures offers additional information about one's body that could be combined with somatic information previously acquired through proprioception.

Cognitive processes such as inner speech (3.3) and imagery (3.4) are likely to participate in self-awareness. Imagery represents the phenomenon of visual experiences in the absence of any visual stimulus from the outside world (Morris & Hampson 1983). The fact that one can have *autoscopic imagery* (i.e., images of the self) suggests that this process is implicated in self-awareness. Empirical evidence is limited: Turner et al. (1978) noted that highly self-conscious people report using imagery as a means of introspection. The idea here is that one can mentally create (or replay) scenes in which the self is an actor (e.g., been pulled over by the police for speeding). Self-aspects (e.g., nervousness) can be deduce from what the actor is mentally seen doing. A more precise suggestion is that imagery can internally reproduce and expand social mechanisms responsible for self-awareness (Morin 1998; see Link C in Figure 3). Mead (1934) already proposed that one social mechanism leading to self-awareness is the opportunity to see oneself as one is seen by others (1.3). Mental images empower one to literally see oneself acting (or having behaved) in given ways as others would see (or have seen) one acting.

The model also postulates that a specific neural network (3.1) which has been shown to be involved in self-referential thinking be activated. This network includes cortical medial structures (e.g., ventromedial and dorsomedial prefrontal cortex), lateral prefrontal cortex, precuneus, insula, posterior and anterior cingulate cortex, and bilateral temporoparietal junction (Northoff, Qin & Feinberg 2010; Salmon et al. 2008; Van der Meer et al., 2009). Furthermore, it suggests that access to autobiographical material (3.5) is fundamental to selfhood. A large part of one's personal identity stems from the recollection one has of one's past personal events (Klein, Rozendal & Cosmides 2002; Markowitsch & Staniloiu 2011). Indeed, the severity of self-awareness impairment in Alzheimer's patients correlates with the severity of autobiography memory deficits (Fargeau et al. 2010). What one did in the past and the events one experienced define the self in the present and actually also plays a role in how one imagines the self in the future. Thinking about the future constitutes an important mental activity as people report experiencing future-oriented thoughts every 16 minutes (D'Argembeau, Renaud & Van der Linden 2009). Current work suggest that autobiographical knowledge serves as raw material for imagining possible future events



(Quoidback, Hansenne & Mottet 2008; Szpunar 2010; also see Smallwood et al. 2011). In short, one's past shapes how one sees oneself in the future.

Note that according to the model the various components of the self examined above represent different levels of analysis (i.e., cognitive versus neural), with different types of cognitive processes (e.g., autobiography) involved in self-awareness being supported by specific brain areas. Furthermore, despite the fact that imagery, inner speech and autobiographical information were discussed separately, it must be emphasized that these processes actively interact in complex ways. Imagery and inner speech are seen here as cognitive processes that contribute to the representation of autobiographical information.

## Conclusion

This article raised the following questions: *How* do we become self-aware, *why* are we self-aware to start with, and *when* are we most likely to engage in self-observation? To summarize, we develop and maintain self-focus (the *how* question) through social interactions from infancy (e.g., non-verbal face-to-face communication) to adulthood (e.g., reflected appraisals) and forward, exposure to physical stimuli (e.g., mirrors, the media—which may initiate perspective taking), activation of medial prefrontal cortex and peripheral brain structures, recall of past personal events, and use of cognitive processes (e.g., imagery) that allow the self to communicate with itself. Self-awareness is beneficial (the *why* question) mostly because it makes self-regulation and inference about others' mental states possible. And we especially tend to focus attention on the self (the *when* question) when exposed to self-focusing stimuli, when differences between the self and others are made salient, and when we engage in inner speech or imagery about the self.

The model discussed in the last part of this paper may be more encompassing than previous attempts at synthesizing known information pertaining to self-awareness, but it is still incomplete. Other influences on the self, most notably culture (Markus & Kitayama 2010) and developmental mechanisms (Lewis 2011), to name only two, also need to be integrated into the big picture. Additional questions which have not been addressed here are animal minds (Stevens 2010) and self-awareness (Edelman & Seth 2009), and the psychopathology of self-awareness (Feinberg 2011a). Part 2 of this review won't do justice to all existing aspects of self-awareness research but will aim at providing the reader with a broader outlook by adding a discussion on the neuroanatomy of self-awareness and the importance of inner speech for self-referential activity.

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