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*Chapter 4*

## **SELF-AWARENESS, INNER SPEECH, AND THEORY OF MIND IN TYPICAL AND ASD INDIVIDUALS: A CRITICAL REVIEW**

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### **ABSTRACT**

Several complex links are postulated to exist between self-reflection, self-talk, and mentalizing. We explore some of these connections by selectively reviewing the pertinent literature. Although some have proposed that thinking about others' mental states (Theory-of-Mind; ToM) gradually leads to reflecting on one's own mental activity (self-awareness; SA), it appears more plausible that either SA brings about ToM or that both concurrently emerge in development, possibly mediated by language, early social interactions, and/or inner speech (IS). Early studies attempting to locate SA in the brain used self-recognition as an operationalization of the former (thus equating the two) and prematurely concluded that SA reliably activates right hemispheric sites. More recent brain-imaging experiments, which embrace a more encompassing definition of SA, rather show a consistent recruitment of areas located in both hemispheres with a bias toward left sided areas. A growing number of studies looking at cognitive and behavioral deficits in children and adults with Autism Spectrum Disorder (ASD) suggest that SA, ToM, and IS are lacking in these individuals. In addition, preliminary work examining typical and ASD individuals seems to indicate that IS is recruited when people reflect on their own and others' thoughts, emotions and intentions, and that IS suppression leads to poor performance on ToM tasks. Numerous methodological limitations are highlighted, notably those pertaining to variable ToM and IS measurement across studies. We consider these limitations and point toward future research avenues, for example, assessing SA, ToM, and IS performance in a nonverbal ASD population. Given the contradictory nature of the evidence reviewed, we conclude that causal claims about SA, IS, and ToM deficits in ASD are premature and posit potential intervention strategies mediating their complex relationships.

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## INTRODUCTION

Self-awareness (SA), Theory-of-Mind (ToM), and inner speech (IS) arguably constitute the backbone of social cognition. Indeed, objectively observing, monitoring, and assessing the self (SA), thinking about others' thoughts, emotions, needs, and intentions (ToM), and talking to oneself about oneself and others (IS) all contribute to self and other perception, as well as smooth navigation in the social world. SA, ToM, and IS also represent processes that are deeply dependent on the possession of a self. By definition SA is awareness of *self*; understanding others' mental states (ToM) plausibly requires an understanding of the *self's* own mental states (Keenan, Gallup, and Falk, 2003); and IS, or *self-talk*, very frequently is about the *self* (Morin, Uttl and Hamper, 2011). Recent models of consciousness and the self in humans and non-human animals (Abraham, 2013; Berkovich-Ohana and Glicksohn, 2014; Boly et al., 2013; Demertzi, Vanhaudenhuyse, Brédart, Heine, di Perri, and Laureys, 2013; Gallagher, 2013) emphasize the recruitment of cortical midline structures together with the experiencing of a subjective timeline, emotions, and a sense of self. In this chapter, we review the pertinent literature on numerous postulated links between SA, ToM, and IS. The review is not meant to be exhaustive given its large scope, although effort has been deployed to include as many significant research contributions as possible. Part 1 explores the relationship between SA and ToM, as well as the controversial question of the localization of these processes in the brain. There is a robust divide between those who argue that SA and ToM recruit mostly right sided sites (Keenan, Wheeler, Gallup, and Pascual-Leone, 2000) and those who suggest a more important contribution of the left hemisphere (Gazzaniga, 2000). Others rather posit that self-referential processes are scattered throughout the brain (Legrand and Ruby, 2009). A careful review of past as well as more recent brain-imaging studies favours the left-sided argument and suggests that IS (located in the left hemisphere) is substantially activated during SA tasks (Morin and Hamper, 2012). Part 2 focuses on SA and ToM deficits observed in Autism Spectrum Disorder (ASD). Theories of ASD are reviewed, together with diagnostic criteria, comorbidity, abnormal brain activity, development and outcomes (e.g., abuse, work), and methodological issues. Part 3 examines mixed evidence of IS involvement in ToM tasks in typical individuals and IS deficits in ASD individuals which are presumably associated with poor mentalizing capacities. It reviews numerous aspects of private speech and IS, such as their characteristics, development, neuroanatomy, content and functions, underlying processes, moderating and mediating factors, as well as potential third factors. Part 3 also critically looks at measurement and methodological issues.

## PART 1. SELF-AWARENESS AND THEORY OF MIND

### 1. Overview

#### 1.1. Definitions and Functions

##### 1.1.1. Self-Awareness

A *conscious* organism can successfully process incoming information from the external environment and respond to it adaptively (Natsoulas, 1996), whereas a *self-conscious* (aware)

organism actively identifies, processes, and stores information coming from the internal environment—the self (Morin, 2006). At a basic level, *self-awareness* (SA) constitutes attention focused inward as opposed to outward (Mead, 1934), or the ability to become the object of one's own attention (Duval and Wicklund, 1972; Silvia and Duval, 2001). Being self-aware includes a sense of spatial unity of the self and the physical body, i.e., *bodily self-consciousness* (Kyselo, 2014), that is, (1) *body ownership*, or a feeling of owning one's body, (2) *self-location*, or the experience of being a body with a given location in space, and (3) *agency* for one's bodily actions. Sense of agency is distorted in schizophrenic patients (Hur, Kwon, Lee, and Park, 2014). Bodily self-consciousness is supported by brain structures representing the body. These representations have recently been shown to be connected to the immune and vestibular systems (Costantini, 2014; Ferrè, Lopez, and Haggard, 2004) as well as the anterior insula (Picard and Craig, 2009). While there is no doubt that non-human animals possess body SA as demonstrated by visual self-recognition in some species (Bard, Todd, Bernier, Love and Leavens, 2006; Gallup, Anderson and Shillito, 2002) and appropriate navigation in their physical environment (Morin, 2012a), it is far from obvious that they exhibit SA of internal states as described below (Carruthers, 2008; Mitchell, 2002) or ToM for that matter (Heyes, 1998—but see Call and Tomasello, 2008, about possible partial ToM in chimpanzees).

Human SA involves thinking about any possible private (internal) and public (visible) self-aspects (Ben-Artzi, Mikulincer, and Glaubman, 1995; Fenigstein, 1979; Wicklund and Gollwitzer, 1987) such as one's emotions, personality traits, preferences, goals, attitudes, perceptions, sensations, intentions, and so forth. The term *metacognition* is used to designate the activity of thinking about one's own thoughts (Smith, 2005). Self-awareness comprises thinking about one's past (autobiography; Markowitsch, and Staniloiu, 2011) and future (prospection; D'Argembeau, Renaud, and Van der Linden, 2011; Szpunar, 2010), self-recognition (Prior, Schwartz, and Gunturkun, 2008; Soler, Pérez-Contreras and Peralta-Sánchez, 2014), self-description, self-evaluation and self-esteem (Duval and Wicklund, 1972; Orth and Robins, 2014), mind-wandering (Smallwood, Schooler, Turk, Cunningham, Burns, and Macrae, 2011), self-regulation (Baumeister and Vohs, 2003), self-directed speech (Morin, 2012b; Morin et al., 2011), self-efficacy (Bandura, 1977), death awareness (Gallup, 1998), and ToM (see 2.2 below).

Healthy SA of the *self-reflective* type (i.e., driven by curiosity about the self; Trapnell and Campbell, 1999) potentially leads to a host of positive psychological effects (Silvia and O'Brien, 2004), most notably self-regulation and self-improvement (Bandura, 1977). Excessive and redundant self-focus constitutes *ruminat*ion (Nolen-Hoeksema, Wisco, and Lyubomirsky, 2008; Smith and Allow, 2009) and is associated with various forms of psychopathology (Leary, 2004; Pyszczynski and Greenberg, 1987; Woody and Rodriguez, 2000) such as depression and social anxiety. These associations are moderated by factors like characteristics of the populations studied and type of self-focus (e.g., private vs public; Mor and Winquist, 2002). One response to undesirable SA is escape from the self (Baumeister, 1991) and its ultimate manifestation is suicide (Baumeister, 1990; Chatard and Selimbegovic, 2011; Schaller, 1997). Note that a *lack* of SA is presumably linked to other disorders such as psychopathy and ASD (Philippi and Koenigs, 2014). Possible SA deficits in ASD are examined in greater detail in Part 2 of this chapter.

In principle, healthy SA should lead to *self-knowledge*, that is, an accurate perception of one's personality and how one is perceived by others (Gibbons, 1983; Silvia, and Gendolla,

2001). In actuality there exists only a moderate correlation between self and others' ratings of personality, as well as between self-ratings on personality scales and actual behavior (Carlson, 2013). This is caused by informational and motivational barriers such as limited access to ambiguous self-information and a persistent desire to perceive oneself positively, known as the *self-enhancement motive* (Sedikides, 2003).

### 1.1.2. Theory of Mind

ToM is the inference that others have a mind despite a lack of evidence to this effect, as no one has direct access to the minds of others (Premack and Woodruff, 1978). *Theory of Mind* represents the ability to attribute mental states such as goals, intentions, beliefs, desires, thoughts, and feelings to others (Gallagher and Frith, 2003). Although some authors include SA in their definition of ToM (i.e., ToM consists in mentalizing about others *and* the self; e.g., Williams, 2010) here we restrict the definition to thinking about *others'* mental life exclusively and use the term "SA" uniquely to designate introspection. While most accounts of ToM performance are mentalistic (i.e., they assume that the observer covertly infers that an agent acts because of specific underlying thoughts and desires), behavioral (non-mentalistic) explanations in terms of stimulus control and reinforcement have been put forward (Dymond and Dermot, 1997; Schlinger, 2009). Theory of Mind allows social agents to predict others' behavior and, on that basis, help, avoid, or deceive others as a function of the situation (Malle, 2002). This ability is also called mind-reading, mentalizing, or taking an intentional stance, and involves a search for prior knowledge about the behavior, agent, or context. Behaviorally, ToM involves attempts to detect subtle signs in the agent's external behavior by tracking gaze and body orientation, as well as reading facial and body expression, etc. (Malle and Holbrook, 2009). Theory of Mind also includes *empathy*, or the ability to experience and understand what others feel without confusion between oneself and others (Decety and Lamm, 2006). Empathy is often divided into cognitive and affective components, with the cognitive aspect being the ability to recognize emotions and the affective dimension representing the ability to share that emotion. ToM has been shown to be selectively impaired in various clinical conditions, including schizophrenia, bipolar affective disorder, acquired brain damage, dementia, psychopathy, and alcoholism (Brüne, 2005; Uekermann and Daum, 2008). Theory of Mind skills have been reported to decline with age (Maylor, Moulson, Muncer, and Taylor, 2002). ToM deficits in ASD are explored in detail in Part 2 of this chapter.

Several ToM domains have been identified by researchers and are summarized as follows by Carrington and Bailey (2009): general ToM, false beliefs, deceit, intentions, empathy, desires, and pretense. *False belief* is the understanding that others can have thoughts that are different than our own. *Deception* is the act of misleading another with one's words or actions. It is conceptually similar to false belief, but differs in that it requires the manipulation of others' beliefs. *Intentions* represent the purpose behind another's behavior, and as such, are necessary for the understanding of social interaction. *Empathy*, as noted above, represents an attempt at understanding others' emotions. Included in intentions are *attributions*, the cognitive processes underlying the interpretation of others' behaviour.

Theory of Mind probably emerged as an adaptive response to increasingly complex primate social interaction. More specifically, ToM could have evolved to facilitate cheating detection and reinforce cooperation (Brüne and Brüne-Cohrs, 2006) as well as to detect individual differences in behavior and cognition (Malle, 2002). Complex social interactions

between individuals, and the specific need to distinguish between sincere and manipulative cooperation for personal gain, as well as predict individual differences, represent major driving forces in the evolution of ToM.

The presence (or absence) of ToM abilities in non-human animals is a highly controversial issue. Povinelli and colleagues (1990) presented chimpanzees with the choice of two experimenters from which to ask for food: one who had seen where food was hidden, and one who did not know and could only guess. In most cases the animals failed to differentially request food from the "knower." However, Hare and colleagues (2001) observed that subordinate chimpanzees could use the knowledge of dominant chimpanzees to correctly choose which container contained food. Based on their extensive communication with the well known captive bonobo Kanzi, Savage-Rumbaugh and colleagues (2000) claim that bonobos have ToM abilities. Call and Tomasello (2008) suggest that the current behavioral evidence points toward chimpanzees being able to understand goals, intentions, perceptions, and knowledge in others—but not others' beliefs. In a representative experiment on intention understanding, animals observe a human experimenter trying to turn on a light with his head as his hands were occupied holding a blanket. The animal reacts to this not by imitating the experimenter's behavior (i.e., turning on a light with its head), but instead by imitating the *intention* behind the action—by turning on the light with its hands. Povinelli and Vonk (2003) propose that chimpanzees form mental concepts of visible, concrete objects in their environments (e.g., trees, facial expressions, other chimpanzees), but not about inherently unobservable things (e.g., God, gravity, love). When tested on ToM abilities, chimpanzees would reason simply about the abstracted statistical regularities that exist among certain events and the behavior, postures, and head movements of others (behavioural abstractions), but not about others' covert mental states.

## ***1.2. Measures and Manipulations***

### **1.2.1. Self-Awareness**

A state of SA can 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 increase SA (Carver and Scheier, 1978; Duval and Wicklund, 1972). Small mirrors produce an awareness of more private aspects of the self whereas large mirrors and audiences induce public SA (Davies, 2005). Various questionnaires have been developed to measure dispositional (stable) self-focus. The Self-Consciousness Scale (SCS; Fenigstein, Scheier and Buss, 1975) was the first SA questionnaire to be designed. Different versions of the SCS have since been constructed (Burnkrant and Page, 1984; Grant, Franklin, and Langford, 2002; Trapnell and Campbell, 1990) and translated in various languages (e.g., Bendania and Abed, 1997). Spontaneous (transient) fluctuations in SA can be assessed using the Situational Self-Awareness Scale (SSAS; Govern and Marsch, 2001). More first-person singular pronouns use in written documents is associated with heightened SA because use of pronouns such as "me," "myself," and "mine" means that the person is thinking about the self (Davis and Brock, 1975). Wegner and Giuliano (1980) have developed the Linguistic Implications Form (LIF), where participants complete ambiguous sentences by selecting the pronouns that seem to fit best. The ratio of first- a shnd third-person pronouns use is calculated in order to quantify SA. With the Self-Noveltly Manipulation (SNM; Silvia and Eichstaedt, 2004),

participants are invited to write about ways in which they differ from others; thinking about what makes one unique induces SA. The Word-Recognition Measure (WRM; Eichstaedt and Silvia, 2003) asks subjects to identify self-relevant or self-irrelevant words as quickly as possible; self-aware participants identify self-relevant words significantly faster than nonself-aware individuals.

Health professionals can measure 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, Cameron Beschin, and Fotopoulou, 2009), where a low match indicates SA impairment and vice versa. Assessment of self-knowledge in healthy individuals can also be done using this technique (see Hoerold, Dockree, O'Keeffe, Bates, Pertl, and Robertson, 2008). Facial self-recognition has been extensively used to infer SA abilities in nonverbal organisms such as infants (Amsterdam, 1972) and chimpanzees (Gallup, 1968; Gallup et al., 2002). As shown in 3.1 below, mirror self-recognition is a highly problematic operationalization of full-blown human SA (Morin, 2007).

**Table 1. Main SA measures and manipulations**

Measure	Description	Authors
Self-Focusing Stimuli	Remind people of their object status and induce SA	Duval and Wicklund (1972)
Self-Consciousness Scale (SCS)	Assesses individual differences in SA	Fenigstein et al. (1975)
Rumination-Reflection Questionnaire (RRQ)	Quantify positive and negative forms of SA	Trapnell and Campbell (1999)
Situational Self-Awareness (SSAS)	Measures spontaneously occurring fluctuations in SA	Govern and Marsch (2001)
Linguistic Implications Form (LIF)	First-person pronouns use indicates SA	Wegner and Giuliano (1980)
Match between self- / other-ratings	A match indicates intact self-knowledge	Cocchini et al. (2009)
Self-Novelty Manipulation (SNM)	Thinking about what makes one unique produces SA	Silvia and Eichstaedt (2004)
Word-Recognition Measure (WRM)	Increased SA leads to faster recognition of self-relevant words	Eichstaedt and Silvia (2003)
Self-Face Recognition	Recognizing one's face in a mirror or on a photograph suggests SA	Gallup (1968)

### 1.2.2. Theory of Mind

Self-report questionnaires have been developed to measure ToM in general (e.g., the Mentalization Questionnaire, MZQ; Hausberg, Schulz, Piegler, Happach, Klöpfer, Brütt, Sammet and Andreas, 2012) or some more specific aspects of ToM such as empathy. To illustrate, the Empathy Questionnaire (EQ; Zoll and Enz, 2010) tackles cognitive and affective empathy, whereas the Toronto Empathy Questionnaire (TEQ; Spreng, McKinnon, Mar, and Levine, 2009) conceptualises empathy as a primarily emotional process (see Sprung, 2010, for a review of ToM questionnaires).

Other manipulations of ToM include tasks requiring recognition of mental state terms, or the attribution of mental states in fictive characters or real people in stories, on static images, single-frame or strip cartoons and videos, as well as real-life social interactions (Carrington and Bailey, 2009). Many of these tasks can be administered when participants' brain activity is being observed in a functional magnetic resonance imaging (fMRI) machine. In a typical mental state terms task (Baron-Cohen, Ring, Moriarty, Schmitz, Costa, and Ell, 1994), participants are asked to listen to two lists of words and decide whether each word is consistent with the theme of the list. One list consists of mental state terms such as *want* and *think*, and the control list may contain words referring to something non-mentalistic like the body. With stories, participants are invited to read scenarios requiring the attribution of mental states to fictive characters (ToM task), pertaining to physical causality, or made up of unlinked sentences (control conditions) (Fletcher, Happe, Frith, Baker, Dolan, Frackowiak, and Frith, 1995). The most well known story used to test false belief understanding is the Sally-Anne task (Birch and Bloom, 2004). This story involves two dolls: Sally and Anne. While the participant is watching, Sally places her marble in a basket and promptly leaves the room. While she is away, Anne removes the marble from the basket and puts it in a box. The participant is then asked: "When Sally returns, where will she look for her marble?" and "Why will she look for it there?" Correct responses require participants to recognize that Sally's knowledge differs from their own. There are multiple variations on this task (some using chocolate in place of the marble), and it varies in complexity. For instance, the more complex or second order ToM tasks add a twist in the story—Sally, unbeknownst to Anne, saw her move the marble. This then requires participants to understand that Anne mistakenly believes that Sally doesn't know.

With static images, participants are shown single frame cartoons and are required to infer the characters' mental state (Brunet, Sarfati, Hardy-Bayle, and Decety, 2000). A manipulation of empathy consists in having volunteers watch photographs of targets undergoing painful surgical procedures (e.g., a needle injection into the hand) (Lamm, Batson, and Decety, 2007). Another common task is the "Reading the Mind in the Eyes" task, in which participants infer the mental state of people based solely on images of their eyes (Baron-Cohen, Wheelwright, Hill, Raste, and Plumb, 2001). Participants can also be asked to observe silent animations of triangles engaged in various interactions. The ToM condition involves interactions implying complex mental states, such as one triangle mocking or surprising the other. In goal-directed interactions, the purposeful actions of one shape determine the actions of the other. In the random motion condition, the shapes move around the screen independently of each other and without interacting (Castelli, Happe, Frith, and Frith, 2000).

Another way of manipulating ToM is the Columbus task (Goel, Grafman, Sadato, and Hallet, 1995), where participants are shown a list of objects and asked if Columbus would know of their function. Not only does this involve inferring another person's knowledge, but inferring the knowledge of a man who lived in a different century. Videos of human actors have also been used to elicit mental state reasoning. Dziobek and colleagues (2006) introduced a video-based test for the evaluation of subtle mindreading difficulties: the Movie for the Assessment of Social Cognition (MASC). The MASC involves watching a short film and answering questions referring to the actors' mental states. Maguire, Woollett, and Spiers (2006) manipulated ToM by having participants play the video game "The Getaway," which involves driving through a virtual London while thinking about other drivers' intentions. Gallagher and colleagues (2002) used a computerized version of the rock-paper-scissors game



and invited participants to play against a human competitor (ToM condition), a computer following a simple rule, and a computer making random choices (control conditions). Simulation of social interactions using robots or avatars is being increasingly used to engage ToM processes (Byom and Mutlu, 2013). Table 2 schematically presents the most common ToM measures and manipulations.

### 1.3. Development and Underlying Mechanisms

#### 1.3.1. Self-Awareness

In this section we briefly examine the developmental trajectory of some SA corrolaries together with two influential proposals pertaining to levels of SA in infancy and childhood. Lewis (2011) notes that the use of personal pronouns, mirror self-recognition, self-conscious emotions, and pretend play all appear within a 15–24 month window of time and are all indicative of underlying self-reflection activity (Lewis and Ramsay, 2004). Mirror self-recognition emerges between the age of 18 and 24 months in children from western cultures (Amsterdam, 1972). Since self-recognition implies the ability to become the object of one's own attention, it is considered by many to require SA (Gallup, 1985, but see 3.1.1 below). Self-recognition occurs about a year later when live videos are used instead of a mirror (Suddendorf, Simcock, and Nielsen, 2007), and its onset is observed even later when a time-delayed video recording is used (Povinelli, Laudau, and Perilloux, 1996).

**Table 2. Main ToM manipulations and measures**

Measure	Description	Authors
Questionnaires	Assess individual differences in ToM	Hausberg et al. (2012)
Mental state terms task	Deciding if words are mental states or not	Baron-Cohen et al. (1994)
Stories	Reading scenarios requiring mental states attribution	Fletcher et al. (1995)
Static images	Looking at cartoons and inferring characters' mental states	Brunet et al. (2000)
Photos	Watching photographs of targets in pain	Lamm et al. (2007)
Reading the Mind in the Eyes task	Inferring mental states based on eyes	Baron-Cohen et al. (2001)
Animations	Watching triangles engaged in various interactions	Castelli et al. (2000)
Columbus task	Participants are shown list of objects and asked if Columbus would know of their use	Goel et al. (1995)
Movie for Assessment of Social Cognition (MASC)	Watching film and answering questions about actors' mental states	Dziobek et al. (2006)
Video games	Driving while thinking about other drivers' intentions	Maguire et al. (2006)

The developmental pattern of self-recognition is *not* universal: self-recognition in same-age children from non-western cultures (e.g., Kenya, Fiji, Grenada, Peru) is much less

frequent and its onset is markedly delayed compared to westerners, probably because of basic cultural differences in the way children understand the self-recognition task (Broesch, Callaghan, Henrich, Murphy, and Rochat, 2011). Self-recognition has also been studied in individuals diagnosed with ASD (Dawson and McKissick, 1984), Down syndrome (Cunningham and Glenn, 2004), Alzheimer's disease (Biringer and Anderson, 1992), and schizophrenia (Lee, Kwon, Shin, Lee, and Park, 2007), with deficits present in all disorders.

New emotions such as shame, pride, guilt, envy, and embarrassment, begin to emerge during the second year of life; these are called *self-conscious* emotions as they require at least a basic sense of self to be experienced (Buss, 1980). These emotions possess five distinct features that differentiate them from other emotions such as sadness and fear: they (1) require SA, (2) emerge later than basic emotions, (3) facilitate the attainment of complex social goals, (4) do not have distinct universally recognized facial expressions, and (5) are cognitively complex (Tangney and Tracy, 2012; Tracy and Robins, 2004).

Lewis (2011) proposes the existence of four levels of SA. Level 1 is Knowing (or "I know") (from birth). At this level there is no "me" yet; when an object in the visual field rapidly expands, infants exhibit surprise and discomfort—they "know" that something is moving in front of them. Level 2 is "I know I know" (between 15 and 24 months). The child can reflect on the self and on what the child knows. Meta-representation at this age is now possible—like the memory of a memory. For example, the child at the first level may experience a memory, and at the second level the child knows it is a memory that he or she is experiencing. Level 3 is "I know you know" (no age suggested). This form of SA incorporates what the child knows with what the child believes others know as well. At this level, children know that they know, and they also know others know. This level partially accounts for the early ability to deceive—for example, "I know you want this last bar of chocolate, so I won't tell you where it is so that I can eat it later." And Level 4 is a more adult-like level where "I know, you know, I know." At this level, not only are there two actors, but each actor has a unique perspective. Only when one has reached the level of knowing that "others know I know" can one's knowledge about what they know be corrected because one can check one's knowledge of what others know against what one knows. This represents the emergence of the ability to recognize false belief.

Rochat (2003) instead suggests that there are five levels of SA. Stage 1 is Differentiation (from birth), when infants are able to differentiate the self from the non-self, as exemplified by the fact that they root significantly less from self-stimulation than when stimulated by another person. Stage 2 is Situation (by 2 months), when infants at this stage can situate themselves in relation to a model, for example, imitating tongue orientation from an adult model. Stage 3 is Identification (by 2 years), when children can recognize themselves in a mirror, as seen above. Stage 4 is Permanence, when children are aware that their sense of self continues to exist across both time and space. Stage 5 is self-consciousness (meta self-awareness), when children can see themselves as seen by others.

A related yet distinct question is: what are the underlying mechanisms that lead to the emergence and maintenance of SA? How can one structure known information about the process of SA into a coherent model? Various proposals of self-reflection have been put forward (Burns and Engdahl, 1998; Feinberg, 2011b; Mischel and Morf, 2002) but most models tend to uniquely focus on isolated neurological or social factors pertaining to SA. Morin (2004, 2011) proposed a more comprehensive neurocognitive and socioecological model which takes into account brain areas, environmental and social influences, as well as

cognitive processes that make SA possible. The model postulates that the three main sources of SA are the physical world, social environment, and self. The physical environment contains objects and structures (i.e., physical boundaries) that participate in the development of bodily awareness and self-world differentiation in infants. Self-focusing stimuli and written material printed in books, articles, and numerous media sources represent information that may foster self-reflection. The social environment includes feedback on the self that the individual receives from others, a social comparison mechanism that leads to perspective taking and the acquisition of self-information, as well as the presence of other individuals observing the self (i.e., audiences)—as seen earlier, an audience represents a self-focusing stimulus that induces SA. The self also develops bodily awareness with proprioception (i.e., information that the body sends to itself, e.g., the position of one's body) and can reflect on itself by using cognitive processes such as IS (see 4 below) and imagery. In Morin's model, SA also relies on the activation of specific brain regions (see 3) as well as autobiographical information.

### **1.3.2. Theory of Mind**

In terms of ToM development now, several studies reviewed in Frith and Frith (2003) suggest that a primitive form of ToM emerges at around 18 months of age, as the following acquisitions are observed: understanding of joint attention, imitation, ability to track a speaker's intention while learning words, understanding of knowing and seeing, dyadic and triadic interactions, and implicit understanding of false belief (Carpendale and Lewis, 2004; Striano and Reid, 2006). Some early components of social cognition, which are probably necessary but insufficient prerequisites for full-blown ToM development, are a preference for social stimuli and a predisposition to detect agency and understand actions. An implicit understanding of mental states exists at 2 years of age. A full development of ToM—that is, an explicit awareness of mental states and their role in the explanation and prediction of others' behaviour—occurs at around 6 years of age, as suggested by the successful completion of second order false belief tasks. This development seems to be related to language acquisition (Garfield, Peterson, and Perry, 2001; Milligan, Astington, and Dack, 2007). More complex ToM tasks have been shown to develop as late as 10 years of age, as has been found in *faux pas* tasks (understanding that someone violated a social norm, such as saying something they shouldn't have and not recognizing their error) (Brüne, 2005). Studies suggest universal developmental stages, applicable to all children, notwithstanding individual differences in the speed of development (Frith and Frith, 2003). See section 2 below for a broader discussion about how the ability to think about others mental states develops in general, regardless of age.

## **2. Possible Relationships Between Self-Awareness and Theory of Mind**

### **2.1. Theory of Mind Leads to Self-Awareness**

Despite the fact that it is entirely conceivable that ToM and SA are bidirectionally linked (i.e., both would influence one another back and forth in development) or evolve in parallel, perhaps both being influenced by other unknown variables, to our knowledge very few

theorists have discussed these possibilities in the literature. In the next two sub-sections we examine the views according to which either ToM leads to SA or SA leads to ToM.

Carruthers (2013) argues against the existence of introspection in the classic sense of direct and privileged access to the self. He notes that people often confabulate when reporting what their inner experiences are, casting doubt on the idea that access to self-information is “direct” (see Part 3, section 5.3). He further claims that the common view according to which we use introspection when reading our own mind and ToM mechanisms when reading others' mind is overly complicated and unrealistic. Instead, he puts forward the notion that we actually use ToM mechanisms *both* when reading our own and others' mind. In that sense, it may be more accurate to state that SA *is* ToM as opposed to ToM *leads to* SA. Carruthers (2013) suggests that SA results from turning our mindreading abilities on ourselves. Essentially, the same mental faculty that evolved for reading the minds of others gets turned toward the self. Attributing thoughts to other people requires observations of their actions and context. SA also relies on anything that is accessible through these same sensory channels, including one's own behaviour and context, in addition to one's own visual imagery, IS, current emotions, and other forms of sensory experience.

## ***2.2. Self-Awareness Leads to Theory of Mind***

The most popular view, as far as we can tell based on this review of literature, is that SA leads to ToM. Although the focus of this sub-section is on the role played by SA in ToM development, it is imperative to keep in mind that SA probably represents a necessary but not sufficient condition in this process. Numerous researchers argue that language (Malle, 2002; Strickland, Fisher, Keil, and Knobe, 2014) and early social interactions (Lee and Hobson, 1998), including conversations between the child and caregivers (Harris, de Rosnay and Pons, 2005; Peterson and Siegal, 1999; Ruffman, Slade and Crowe, 2002), constitute key variables in the development of ToM abilities. One interesting distinction established by Mahya and colleagues (2014) might help clarify why the issue of underlying factors explaining ToM development is so murky. One needs to distinguish between ToM *expression* (what variables are required when engaged in actual online ToM) and ToM *emergence* (what underlying variables need to develop first, leading to future ToM performance). To illustrate, it is plausible that conversations about mental states and others' perspectives might be required for the gradual emergence (development) of ToM but not for online mentalizing *per se*, while IS (together with other executive functions—see Carlson, Moses, and Breton, 2002) could be necessary for the actual expression of ToM, but not for prior development of ToM *per se*. By the same token, one could propose that SA is required only in the emergence of ToM but not in its expression—that is, once fully developed based on introspection of one's own mental states, ToM takes a life of its own and does not necessitate constant introspection when reflecting on others' mental states SA (Morin, 2003).

At any rate, proponents of the *Simulation Theory* argue (contra Carruthers, 2013) that SA and ToM are not reducible to one another (Dimaggio, Lysaker, Carcione, Nicolo, and Semerari, 2008). This view suggests that people use their knowledge of self to understand others—hence, SA precedes and leads to ToM (Focquaert, Braeckman, and Platek, 2008; Gallup, 1985; Hesslow, 2002; but see Saxe, 2005, for an argument against Simulation Theory). People mentally simulate what others might be experiencing inside (e.g., thinking, feeling, wanting, etc.) by imagining what types of experiences they, themselves, might have if they were in a comparable situation. As Keenan et al. (2003, p. 78) put it, “... if I can think

about my thoughts, I should be able to think about your thoughts as well.” Mindreading thus involves the ability to place ourselves in someone else’s “shoes” and imagine how the world looks like from their perspective.

Studies reviewed in Dimaggio et al. (2008) show that the more people are effective at reflecting on their own past (autobiographical knowledge) the better they are at reading others' mind. They observe that changes in levels of SA are associated with changes in ToM abilities. For instance, Ames and Kammrath (2004) report that SA impairment (e.g., in narcissistic individuals) is linked to poor ToM (e.g., empathy). The higher an individual’s private self-consciousness, the better the person is at detecting deception (Focquaert et al., 2008). Actually, the relation seems to be causal: SA development in schizophrenic patients (through self-reflection exercises) *precedes* ToM improvement (Lysaker, Buck, and Ringer, 2007). In a study conducted by Bivona and colleagues (2014), patients with traumatic brain injury were split into two groups (impaired vs adequate SA). Only impaired SA patients performed significantly poorer on ToM tasks, which suggested to these authors the existence of a causal relationship between low SA and perspective-taking (ToM) difficulties in this population of patients.

Two mechanisms for simulating other minds have been proposed: mirroring and self-projection (Molnar-Szakavs and Uddin, 2013; Waytz and Mitchell, 2011). Mirroring represents a more basic pre-reflective, intuitive, and empathic ToM process which contributes to a shared experiential state between observer and target. Self-projection is reflective (it thus implicates SA) and engages cognitive mechanisms that allow one to explicitly think about the inner life of others (Van Overwalle, 2009). Keysers and Gazzola (2007) provide the following examples to illustrate the difference between these two mechanisms: mirroring is involved when one observes another person getting hurt, and self-projection occurs when one tries to decide what gift to give to a foreign colleague.

Mirroring is postulated to be associated with activity of brain areas containing mirror neurons—Broca’s region (left inferior frontal gyrus—LIFG), the primary motor cortex, superior temporal sulcus (STS) area, and parietal cortex (Focquaert et al., 2008). Mirror neurons respond both when a particular action is performed by the individual and when that person observes another person performing the same action. Mirror neurons seem to form a cortical system matching observation and execution of goal-related motor actions (Gallese and Goldman, 1998). When mirroring, we adopt the pattern of brain activity associated with a given mental state just by watching another person in that state. Therefore, we literally mirror mental states. This happens in particular when we can use observable cues about what others are experiencing—e.g., facial expressions, gaze, voice, body movements. (See Baird, Scheffer, and Wilson, 2011; Hickok, 2009; Southgate and Hamilton, 2008, for problems with the view that mirror neurons support the mirroring mechanism of ToM.)

With self-projection we imagine what others' mental states could be like by considering how we would experience them ourselves. We project our own mental states on to others. This happens in particular when observable cues are not available, for example, when we think about distant people, anticipate meeting someone, and so forth. Self-projection is associated with activity in the medial prefrontal cortex (MPFC), precuneus, posterior cingulate, and lateral parietal cortex (Waytz and Mitchell, 2011).

We offer two concluding remarks here. (1) The above analysis views SA as a unitary construct (introspection) which leads to ToM. However, Trapnell and Campbell (1999) convincingly showed that SA is actually made up of two distinct types of self-focus: *self-*

*reflection*, which constitutes an authentic curiosity about the self, and *self-rumination*, which represents anxious attention paid to the self. It is important to realize that only self-reflection leads to ToM (i.e., empathy); self-rumination actually inhibits ToM because the person is too self-absorbed to think about others' mental states (Joireman, 2004; Joireman, Parrott, and Hammaersla, 2002). (2) There are other ways of looking at the emergence of ToM independent of SA. To illustrate, both *Theory-Theory* and *Rationality Theory* views (Carruthers and Smith, 1996; Goldman, 2006, as cited in Focquaert et al., 2008) suggest that attribution of mental states occurs by virtue of an implicitly held theory about the structure and functioning of the human mind, and hold that people are rational agents who infer mental states in others by appealing to what rationality dictates under precise circumstances. According to these two views, ToM is solely achieved by means of theoretical inference and SA is not part of it.

### 3. Neuroanatomy

#### 3.1. Self-Awareness

##### 3.1.1. Initial Findings Based on Face Self-Recognition

Early efforts aimed at determining the neuroanatomical basis of SA relied on *facial self-recognition*, that is, the ability to recognize one's face in a mirror or on a (real or digital) photograph. Spontaneous self-exploration in front of a mirror has only been observed in human primates (Amsterdam, 1972), chimpanzees, orangutans and some bonobos (see Gallup et al., 2002 for a review), elephants (Plotnik, de Waal, and Reis, 2006), dolphins (Reiss and Marino, 2001), and Australian magpies (Prior et al., 2008; but see Soler et al., 2014). These animals also pass the mark test (Gallup, 1970) where they reliably touch a red dot that has been applied to their brow or forehead (or throat feathers in magpies' case) while self-examining in front of a mirror. Gallup's view (1968, 1985, 1997) is that self-directed behaviour suggests that the organism can become the object of its own attention and presupposes precognition of the self (i.e., already existing self-knowledge, SA).

While preliminary results favored a right hemisphere advantage for self-recognition, more recent studies rather implicate both hemispheres of the brain. In behavioural studies, participants are asked to decide if an image represents their own face or that of either a familiar person or an unknown one by pressing buttons with the right or left hand (Keenan, McCutcheon, Freund, Gallup, Sanders, and Pascual-Leone, 1999). Participants tend to respond faster to self-faces, but slower to other faces, with the left hand (controlled by the right hemisphere). Patients with right hemisphere damage tend to fail to recognize themselves in a mirror (Keenan, Rubio, Racioppi, Johnson, and Barnacz, 2005). In early studies with split-brain patients, the right hemisphere seemed better at self-recognition than the left one. Preilowski (1977) presented different pictures of faces, including their own face, to the left and right hemispheres of two patients. Both patients showed greater skin response (an indicator of arousal) when self-faces were shown to the right hemisphere than when projected to the left. Subsequent studies did not replicate Preilowski's clear-cut lateralized results. For example, Sperry and colleagues (1979; also see Turk, Heatherton, Kelley, Funnell, Gazzaniga, and Macrae, 2002; Uddin, Rayman and Zaidel, 2005), tested two split-brain

patients and showed that both correctly picked a picture of themselves (among various pictures of family members and friends) with their right hand when the picture was presented to the left hemisphere, and vice versa.

In a typical functional-imaging study of self-face recognition, participants are invited to decide if an image represents their own face, the face of a friend, or the face of a stranger while brain activation is being recorded with positron emission tomography (PET) or fMRI (Platek, Keenan, Gallup, and Mohamed, 2004). Older studies tended to report right hemispheric activation during self-recognition, while more recent ones rather suggest bilateral activation. Platek and colleagues (2008) reviewed several newer studies and concluded that self-recognition activated a widely distributed and bilateral network that included the left fusiform gyrus, bilateral middle and inferior frontal gyri, as well as right precuneus.

All previously reviewed studies assume that facial self-recognition is indicative of full blown, mature human SA, which most likely it is not (Morin, 2002). While self-recognition undoubtedly requires bodily SA, some argue that it does not imply awareness of one's (or others') mental states (Mitchell, 1993, 2002; Povinelli, 1995). In bodily SA, all the organism needs to achieve self-recognition is a mental representation of its own physical self, where the organism matches the kinesthetic representation of the body and face with the image seen in the mirror (or photograph). Reflection on one's mental states is totally unrelated to self-recognition. This signifies that self-recognition and SA should not be equated (Morin, 2003, 2010), so that even if studies were able to show that the former is located in the right hemisphere (and they don't), it would not mean that the latter is produced by the same hemisphere.

### **3.1.2. Subsequent Brain-Imaging Studies**

As suggested in 1.1.1, SA implies much more than self-recognition. Accordingly, brain-imaging studies have also examined neural activity associated with different types of self-focus, such as mental time travel (autobiographical retrieval and prospection), evaluation of one's current emotional experience, sense of agency, judgments about one's personality traits, intentions, preferences, etc. To illustrate, a typical personality trait study invites participants to 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) (Kelley, Macrae, Wyland, Caglar, Inati, and Heatherton, 2002). In a classic brain-imaging study of autobiographical memory, volunteers are scanned while listening to a narrative recounting a memory of their own (self-condition) or describing another person's memory (control condition) (Fink, Markowitsch, Reinkemeier, Bruckbauer, Kessler, and Heiss, 1996). A standard brain-imaging study of emotions asks participants to view various images and invite them to reflect on the emotional response that these stimuli produce; an example of a control task is categorizing the pictures into groups (e.g., color/black-and-white) (Goldberg, Harel, and Malach, 2006). In a comprehensive meta-analysis of experiments using self-referential tasks and neuropsychological case studies evaluating patients' SA, Gillihan and Farah (2005; also see Northoff, Heinzel, de Greck, Bermphohl, Dobrowolny, and Panksepp, 2006) concluded that self-referential tasks engage a wide network of regions located in both hemispheres of the brain. The consensus today is that self-related processing is associated with increased activity in the ventromedial (vmPFC) and dorsomedial (dMPFC) prefrontal cortex, precuneus, insula, posterior cingulate cortex (PCC), left and right temporoparietal junction (TPJ), and anterior cingulate cortex (ACC), left dorsal caudate, thalamus, and left

temporal pole (Denny et al.; 2012 Salmon, D'Argembeau, Bastin, Feyers, Phillips, Laureys, Maquet, and Collette, 2008).

### 3.1.3. Recent Studies

Brain imaging studies of self-referential processing published more recently further support the view that SA activates a complex distributed and bilateral neural network biased toward the left hemisphere (Bergstrom, Vogelsang, Benoit, and Simons, 2014; D'Argembeau, Cassol, Phillips, Balteau, Salmon, and Van der Linden, 2014; Herwig, Kaffenberger, Schell, Jäncke, and Brühl, 2012; Lalanne, Grolleau, and Piolino, 2010; Munevar, Cole, Ye, Yang, Zheng, Krishnamurthy, and Haacke, 2014; Shad, Keshavan, Steinberg, Mihalakos, Thomas, Motes, Soares, and Tamminga, 2012; van der Meer, de Vos, Stiekema, Pijnenborg, van Tol, Nolen, David, and Aleman, 2013). Part of the reason for this left-hemisphere asymmetry may be that SA often recruits IS processes located in the LIFG (Morin and Hamper, 2012). Several researchers emphasize the importance of cortical midline structures (CMS; D'argembeau et al., 2008; Northoff, 2014; Ries et al., 2007; Summerfield, Hassabis and Maguire, 2009). Moran and colleagues (2013) suggest that CMS are specialized for representing any type of social information, including the self; they are also responsible for the direction of our thought processes on a moment-to-moment basis and represent a hub integrating information from disparate neural processing systems into a "conscious workspace" (Baars, 2002). Current research also shows that vMPFC gets more activated as stimuli presented to participants gain more personal relevance, or self-relatedness, whereas dMPFC gets more activated when stimuli represent other persons (Abraham, 2013; Molnar-Szakavs and Uddin, 2013; Moran, Heatherton, and Kelley, 2009). This principle also applies to mentalizing, where thinking about similar others is associated with vMPFC activity and thinking about dissimilar other is rather associated with dMPFC (Mitchell, Macrae, and Banaji, 2006).

Patterns of brain activity associated with various self-domains slightly differ. Molnar-Szakavs and Uddin (2013; also see Morita, Tanabe, Sasaki, Shimada, Kakigi, and Sadato, 2013) suggest that self-processes can be divided into physical and psychological, echoing a distinction originally made by Gillihan and Farah (2005). Reflecting on aspects of the physical self (e.g., one's face in self-recognition tasks) is linked to activity in the mirror neuron system mostly located in the right hemisphere, whereas reflecting on one's (or others) mental states and more abstract self-characteristics (e.g., personality traits) activate the MPFC and more left-sided areas. Sugiura (2013) organizes self-processes in three categories: the physical self, the interpersonal self, and the social-value self. The *physical self* represents the equivalent of bodily self-consciousness discussed in 1.1.1. It is the body-grounded self that dissociates one's physical existence from the external environment. It includes the ability to dissociate self from non-self, like one's own face from another's face. The *interpersonal self* refers to the awareness we have that others can observe us. The SCS mentioned in 1.2.1, particularly its public subscale, precisely measures the degree to which a person has this type of awareness. The *social-value self* focuses on the self-evaluative dimension of SA, this awareness we may have of a possible gap between our current self and our ideal self (Duval and Wicklund, 1972; Higgins, 1987). Examples of thoughts reflective of such self-evaluation are "Am I good-natured?", "Am I good-looking?", "Am I intelligent?", or "Am I successful in my career?" Table 3 below presents different patterns of brain activity as a function of these three selves (Sugiura, 2013).



**Table 3. Brain activation associated with three categories of SA proposed by Sugiura (2013)**

Physical Self	Interpersonal Self	Social-value Self
- Visual association cortex - Auditory association cortex - Somatosensory association cortex - Motor association corticles - Supplementary motor area - Anterior cingulate cortex - Intraparietal sulsus - Insula	- MPFC - ACC - TPJ/STS - ATC - Insula - Cerebellum	- vMPFC - PCC - Precuneus

### 3.1.4. Self-Awareness and the Right Hemisphere Fallacy

In a meta-analysis reviewing 107 published neuroimaging studies of self-referential activity, Denny and colleagues (2012) came to the following conclusion: "... self-related judgments were associated with almost entirely left-lateralized activity, including left vPFC, left anterior and mid-insula, and dorsal caudate. This stands in contrast to prior work that has associated self-related judgments with right-lateralized activity" (p. 1748). Why is it that prior studies have favoured the right hemisphere in relation to SA? As seen in 3.1, early brain imaging and behavioural studies of facial self-recognition reported more activity in the right PFC (Keenan et al., 2000); subsequent experiments rather implicated a bilateral network (Platek et al., 2008). This discrepancy may be accounted for by the very small sample of participants tested in early studies, as well as small number of studies overall, leading to unreliable results and invalid conclusions. Another factor is that some authors have relentlessly pushed the idea of right hemisphere superiority for SA processes despite contrary evidence (Feinberg and Keenan, 2005; Keenan et al, 2005; Keenan and Gorman, 2007). Furthermore, several neuropsychological reports suggest that injury to the right hemisphere consistently leads to disturbances of the self (Feinberg, 2011a), motivating some to conclude that the self is located in the right hemisphere. To illustrate, some patients fail to recognize themselves in a mirror (mirror sign syndrome), may experience dissociation which includes derealisation (feeling outside of one's body), may suffer from asomatognosia (a failure to recognize specific body parts), or exhibit anosognosia (unawareness of paralysis of one side of the body). It is remarkable that all seem to involve a distortion or absence of a *body* representation, precisely the type of kinesthetic information postulated to be necessary for mirror self-recognition, as seen in 3.1.1. We thus suggest that the mirror sign syndrome, asomatognosia, dissociation, and anosognosia—conditions all caused by damage to the right hemisphere—are unrelated to genuine SA (the type that involves access to one's mental events) and instead are linked to one's mental conception of one's body or lack thereof (Morin, 2010).

### 3.2. Theory of Mind

Early efforts at localizing ToM processes in the brain were also biased toward the right hemisphere. Stuss and colleagues (2001) reported cases studies of patients with (often right) frontal lesions exhibiting deficits in visual perspective taking and at detecting deception. Note that visual perspective taking (e.g., imagining seeing a scene from the perspective of another person) represents a questionable measure of ToM because it does not involve thinking about

others' mental states *per se*. A common initial rationale for right hemisphere involvement in ToM was as follows: the right hemisphere sustains self-recognition; self-recognition implies SA; thus SA is located in the right hemisphere; ToM requires SA (Simulation theory); thus ToM is located in the right hemisphere (Guise, Kelly, Romanowski, Vogeley, Platek, Murray, and Keenan, 2007; Keenan et al., 2003). This reasoning is flawed because (1) self-recognition, SA, and ToM cannot and should not be equated (Morin, 2002, 2003, 2007, 2010), and (2) these processes recruit both hemispheres of the brain as seen in 3.1.3.

More recently, Ortigue and colleagues (2009; also see Ortigue, Sinigaglia, Rizzolatti and Grafton, 2010) reported that the right hemisphere of a split-brain patient was better at understanding the intention of an agent (the “why” of action) while the left hemisphere was superior at understanding the agent's action *per se* (the “how” of action). Despite this, an overwhelming number of brain-imaging studies rather show wide bilateral activation while participants perform ToM tasks. In a representative experiment (Calarge, Andreasen, and O’Leary, 2003), healthy volunteers are invited to produce a fictive story about the mental state of a stranger whom they imagine meeting on a park bench. Brain activity recorded during the ToM task is then contrasted to that of a control task consisting in reading a story requiring no mental state identification. Carrington and Bailey (2009) reviewed 40 fMRI studies of ToM and reported *bilateral* activation in the MPFC, STS, TPJ, and ACC. Note that some of these activation loci are also found in SA studies, an overlap which suggests, as the Simulation view does, that ToM and SA are connected (Focquaert et al., 2008).

Van Overwalle (2009; also see Van Overwalle, 2011) reviewed over 200 studies and identified the same brain areas activated during ToM task completion. In addition, his analysis suggested that the TPJ is mainly responsible for transient mental inferences about others' goals, desires and beliefs, as well as emotional situations (Decety and Lamm, 2006), while the MPFC subserves the attribution of more enduring traits and qualities about the self and other people. Furthermore, there is more significant MPFC activation as more task stimuli contain mentalizing elements. That is, while only 10% of the studies without mentalizing activate the MPFC, 80% of the studies with (almost) full mentalizing content do so. Finally, the MPFC is not exclusively activated during ToM—it is also involved in thinking about the self (SA), as when participants are mind-wandering, reading narratives, or mentally time traveling in their past or future. As noted in 3.1.3, mentalizing about similar others is linked to vMPFC activity while thinking about dissimilar others is instead associated with dMPFC (Keysers and Gazzola, 2007).

## 4. Inner Speech and Self-Awareness

### 4.1. Overview

Here we examine how IS participates in self-reflective activities by presenting empirical evidence and theoretical relationships. We wish to put forward the argument according to which IS is deeply involved in SA. This in turn will suggest that IS may be importantly involved in ToM because it (at least partially) relies on SA. Furthermore, it will become plausible then that ToM deficits in ASD are (at least partially) attributable to IS deficits.

#### **4.2. Empirical Evidence**

IS represents speech for self expressed internally (Langdon, Jones, Connaughton and Fernyhough, 2009). Part 3 of this review examines this phenomenon in greater detail; this section uniquely addresses the idea that SA heavily relies on IS (Carruthers, 2013; Morin, 2005; Morin and Everett, 1990).

Thought listing and thought sampling studies (Morin et al, 2011; Uttl, Morin, and Hamper, 2012) show that people talk to themselves *about themselves* a lot—in decreasing order, when self-evaluating and about emotions, physical appearance, relationships, problems, food, behaviour, financial situation, stress, performance, future, education, beliefs, others' opinion of self, goals, and desires. This is undeniable proof that IS is indeed used for introspection purposes. Significant positive correlations have been noted between diverse measures of SA and IS (Schneider, Pospeschill, and Ranger, 2005; Siegrist, 1995), suggesting that the more people reflect on themselves the more they tend to use IS, and vice versa. Neurological case studies of patients experiencing loss of IS following brain injury point to deficits in SA—for example, distorted sense of individuality, difficulties retrieving autobiographical memories, and lack of self-conscious emotions (Morin, 2009; also see Moss, 1972). In a meta-analysis of over 100 brain imaging studies of self-referential activity, Morin and Hamper (2012) observed that sixty percent of all studies identified LIFG activity—the brain region most often associated with IS use.

It is worth acknowledging that talking to oneself about one's inner experiences does not automatically lead to accurate self-knowledge (Mega and Volz, 2014). Research by Schooler and Engstler-Schooler (1990) suggests that sometimes using words (i.e., through IS) when describing some internal experiences may cause a “translation dissociation” between the contents of experience and one's belief about the contents of experience (i.e., SA), called “introspective error.” This may occur in particular when one tries to verbally introspect about complex non-verbal stimuli. To illustrate, participants asked to watch a short video of a bank robbery performed worse at identifying the robber from a photo array if they had previously written a detailed description of the robber's appearance (considered to be IS activity) compared to a control group.

#### **4.3. Theoretical Relationships between Inner Speech and Self-Awareness**

At least five theoretical explanations can be evoked to account for the existence of a link between IS and SA (Morin, 1993, 1995, 2005). (1) One view of SA suggests that we can become cognizant of a mental state when we generate a higher-order thought about that state (Carruthers, 2002). Of course, one effective way to generate such a higher-order thought about some mental state is to talk to oneself about it. (2) IS can reproduce social mechanisms leading to SA. Cooley (1902) observed that people often comment on our personal characteristics and behaviours. These reflected appraisals allow us to learn about ourselves and can produce self-focus. We can re-address to ourselves some of these appraisals from others by using IS. Observations and inferences about our thoughts, feelings, and behaviours made by others (e.g., “you are a hard working person”) might imprint on our own IS a tendency to address such self-informative remarks to ourselves (e.g., “I am a hard working person”). Mead (1934) suggested that the presence of other persons in our environment motivates us to take their mental perspective in order to obtain an objective point of view on ourselves. Once in this position, we may become self-aware and acquire information about ourselves. For instance, a person could learn that he or she tends to be impatient after

observing someone else being respectful and calm in a similar social situation. We can engage in fictional conversations in which we verbalize to ourselves a different, and thus more objective, point of view about ourselves. To illustrate: “This driver remained calm and composed despite being abruptly cut off by that other driver. I would have lost it! Yes, I am impatient in that type of situation...”

(3) IS can “translate” self-information into a verbal representation; for example, an emotion (self-information) becomes “I feel happy” (verbal representation) once transformed by IS. This creates a redundancy within the self-system because in addition to the experienced emotion there now is a verbal representation of it, which then produces a virtual distance between the self and self-information. This gap makes it possible for the self to distance itself from what is presently being experienced (e.g., the emotion), which facilitates self-observation. Several authors have noted that IS often has a dialogical quality where one asks a question and then answers it (McCarthy-Jones and Fernyhough, 2011). This observation, which implies a duality of agency in the conversation generated in IS, is consistent with the above “distance” proposal. (4) IS is known to play a significant positive role in problem solving situations (Fernyhough and Fradley, 2005). Children and adults perform better on problem solving tasks when engaging in inner or outer speech-for-self, as long as verbalizations are focused on problem resolution (Winsler, 2009). The self may be seen as a question (problem) to be solved (Who am I? What characterizes me? What did I do and why?), where the solution constitutes self-knowledge and self-information, the data required to solve the problem. In this perspective, the process of SA can be understood as a problem-solving situation, and IS as an effective cognitive tool one employs to reach a “solution” to this “problem”. For example, one can emit self-statements that help formulate (a) a clear definition of the problem (“How did I do?”), (b) an optimal approach to the problem (“I will try to remember what happened and everything I did in detail”), (c) problem-solving verbalizations (“The first thing I did was Z. Then X happened, and I then said W”), (d) self-evaluative comments (“Good! I’m getting somewhere!”), and (e) self-directive notes (“I don’t need to take this into consideration, it’s not pertinent”). Some of these categories of self-verbalizations have been proposed by Kendall and Hollon (1981). (5) Language (and by extension IS) allows us to verbally label self-aspects (Zelazo, 2004), potentially facilitating the identification of self-information, in particular with respect to more abstract and conceptual material (Morin and Hamper, 2012). Obviously, one can feel sad without having to say to oneself “I am sad,” but one may assess one’s sadness more acutely if one talks to oneself about it. For example, “I feel sad... also somewhat disappointed by X... and hurt too...” Some self-aspects (e.g., opinions, values) arguably need to be verbally labelled in order to fully become available to consciousness.

## 5. Summary

In Part 1 of this chapter we selectively reviewed the literature on SA and ToM. Both terms were defined and their respective functions were outlined. In essence, SA constitutes the ability to focus attention on the self and to organize self-information into a coherent system—a self-concept—in order to self-regulate. ToM represents the capacity to think about others’ mental states so that understanding and predicting behaviour for survival purposes

become possible. Both abilities can be measured objectively using self-report questionnaires and behavioural measures, and both seem to be almost fully developed by the age of six. The most widely accepted view regarding possible links between SA and ToM is Simulation Theory, according to which one comes to grasp others internal states by imagining what one would experience in a comparable situation. Despite early reports suggesting right hemisphere superiority for SA and ToM functions, it is now well established that both rely on bilateral brain activity with a special role played by the left hemisphere for SA. We also suggested that IS—the focus of Part 3 of this chapter—is importantly involved in self-reflective activity.

## **PART 2. SELF-AWARENESS AND THEORY OF MIND IN AUTISM SPECTRUM DISORDER**

### **1. ASD**

#### ***1.1. Overview***

Part 1 offers an in-depth examination of SA and ToM, outlining discrepant evidence in the literature and the issues that stem from these conflicting accounts. Part 3 of this chapter is dedicated to exploring literature pertaining to IS in relation to ToM and ASD. Part 2 looks at if and how SA and ToM are impaired in ASD.

#### ***1.2. History***

Two individuals in the early 1940s redefined a series of observed behaviours in two separate collections of case-studies. The first was Leo Kanner, with his publication of “Autistic Disturbances of Affective Contact” in 1943. The second was Hans Asperger, with his observations collected in “Die ‘Autistischen Psychopathen’ im Kindesalter” in 1944. Although both Kanner and Asperger were born in Austria and formally trained in Vienna, their paths never crossed during their lifetimes (Frith, 1991).

Kanner (1943) and Asperger’s (1944, trans.) case-studies painted seemingly dissimilar portraits; however, despite the varying brushstrokes, the paint and colors were entirely the same. Abnormal language use was identified with every observed individual: whether it be the complete lack of language, pronoun reversal, or the creation and/or innovative use of language, it appeared as though language acquisition and execution were somehow affected by this syndrome. Diminished eye-contact and distant gazes, coupled with flat or inappropriate affect were also notably mentioned in nearly all accounts. In Kanner’s 11 case-studies, most of the children lacked gross-motor skills and were unable to coordinate their bodies to their environment. Asperger noted similar difficulties, but he also documented a handful of children who struggled so much with their fine-motor skills that the expectation of holding a pen turned into a drawn-out ordeal.

In the following excerpt, Kanner (1943) describes Alfred who was “extremely tense during the entire interview and very serious-minded to such an extent had it not been for his juvenile voice, he might have given the impression of a worried and preoccupied little old man” (p. 235). Kanner also noted that Alfred “never smiled” (p. 235). Similarly, Asperger (1944) described Ernst K., a seven-and-half-year-old boy. Ernst still required someone to

“dress him, since, by himself he would dwadle endlessly and also make a lot of mistakes. He had learnt to eat by himself only recently and was still a messy eater” (p. 59).

Kanner spoke of “autistic aloneness” (Barnbaum, 2008) and Asperger (1944) highlighted that Autism, as a title, was derived from a distinct set of behaviours noted in schizophrenic patients. According to Asperger, “‘autists’ have severely disturbed and considerably limited interactions. The autist is only himself (cf. Greek word *autos*) and is not an active member of a greater organism which he is influenced by and which he influences constantly” (trans., p. 38).

### ***1.3. Prevalence and Diagnostic Criteria***

#### **1.3.1. DSM**

In order to diagnose an individual with ASD, mental health professionals adhere to criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM), now in its fifth edition. ASD made its debut as Infantile Autism in the DSM-III (APA, 1980), while Asperger’s Syndrome first appeared in the DSM-IV (APA, 1994).

Diagnosis for Infantile Autism in the DSM-III was determined by the presence of six criteria: (1) age of onset, (2) lack of responsiveness to social stimuli, (3) deficits in language development, (4) peculiar speech patterns (when speech was present), (5) bizarre responses to environmental stimuli, and (6) the absence of delusions and hallucinations (APA, 1980). All of the characteristics captured in Kanner (1943) and Asperger’s (1944) observations were accounted for, and appropriately segregated from childhood schizophrenia. Although the prevalence of nonverbal ASD was not explicitly stated in the DSM-III, according to Autism Speaks (2012), “about 25% of individuals with ASD are nonverbal, but can learn to communicate using other means.”

The DSM-IV and DSM-IV-TR classified autism and Asperger’s Syndrome under the same umbrella heading of Pervasive Developmental Disorders (APA, 1980; APA, 2000). Rett’s Disorder, Childhood Disintegrative Disorder, and Pervasive Developmental Disorder Not Otherwise Specified were also included under the Pervasive Developmental Disorders heading. Diagnosis for any of these conditions relied on the presence of at least six qualitative features as part of a triad of symptoms (APA, 1980).

In May of 2013, diagnostic criteria changed again with the publication of the DSM-V. Pervasive Developmental Disorders ceased to exist and were replaced by Autism Spectrum Disorder (APA, 2013). Diagnosis was now determined by a dyad instead of a triad of symptoms (APA, 2013; Lai, Lombardo & Baron-Cohen, 2014), which relied on the presence of “persistent deficits in social communication and social interaction across multiple contexts,” coupled with “restricted, repetitive patterns of behaviour, interests, or activities” (APA, 2013, p. 50). Severity for each of these two criteria is to be specified, identifying the unique needs of each individual diagnosed. Mental health professionals were to also include additional markers to account for the spectrum manifestations of ASD: (1) with or without intellectual or language impairment, (2) associated with a known medical, genetic, or environmental factor; (3) associated with another neurodevelopment, mental or behavioural disorder, and finally, (4) whether or not catatonia (i.e., a condition affecting motor abilities) was present (APA, 2013).

### 1.3.2. Prevalence

The prevalence of autism was considered rare with 2 to 4 cases per 10,000 individuals in the DSM-III (APA, 1980), and 2 to 20 reported cases per 10,000 individuals in the DSM-IV-TR (APA, 2000). Between 2000 and 2012, 16,741 studies related to ASD were published, compared to 6054 between 1940 and 1999 (Lai et al., 2014). This spike came partially as a result of highly publicized reports regarding the potential link between ASD and vaccines, specifically the Measles, Mumps and Rubella (MMR) vaccination, as well as any vaccine containing mercury (Barnbaum, 2008; Dover & Le Couteur, 2006; Lai et al., 2014). It has now been widely established that vaccines do not play a role in the presence of ASD. With this in mind, environmental factors continue to be speculated with no definitive casual factor identified.

Research in genetics has revealed distinct chromosomal loci linked to an ASD diagnosis; however, there is no known “autism gene,” and the actual inheritance of ASD has yet to be studied as very few individuals with ASD go on to have children (Barnbaum, 2008; Dover & Le Couteur, 2006; Lai et al., 2014). Twin studies have indicated that heritability can be as high as 80% (Hoekstra, 2014 as cited in Lai et al., 2014) and risk for ASD in males appears to be up to eight times more likely than in females (Brizendine, 2006). It is unclear if this is due to a diagnostic bias (APA, 2013; Wing, Gould, and Gillberg, 2011), or if males are more susceptible to chromosomal/genetic factors. Asperger (1944) and others have argued that ASD may be an extreme manifestation of the male brain (i.e., hormone levels; see Barnbaum, 2008).

Dover and Le Couteur (2006) address the rising prevalence rates of ASD diagnoses and posit some potential mediating factors. For one, increased attention has led to earlier screening and identification. This has led to the development of reliable screening measures such as the Autism Diagnostic Interview Revised (ADI-R), the Diagnostic Interview for Social and Communication Disorders (DISCO), and the Autism Diagnostic Observation Schedule (ADOS). The ADI-R, ADOS and DISCO are used alongside other diagnostic tools, such as familial history and cognitive assessments, to validate the diagnostic criteria in the DSM (Dover & Le Couteur, 2006). Another potential mediating factor is stigma: Barnbaum (2008) draws on research from Frith (2003) and Shattuck (2006) evidencing the concurrent inverse relationships from 1994 to 2003 between autism diagnostic rates and diagnostic rates for mental retardation. That is, as diagnostic rates for autism increased, diagnostic rates for mental retardation decreased, potentially indicating greater social acceptance for an autism diagnosis over a mental retardation diagnosis (Barnbaum, 2008).

Increased awareness and acceptance can also lead to false-positive diagnoses. Siegel (as quoted in Wallace, 2014) postulates that of the 10 assessments she is asked to complete every week, six do not fit the diagnostic criteria for ASD. Autism itself has not changed; rather, the scope of inclusive diagnostic criteria has broadened. As Siegel noted, it is unclear whether impairment level is adequately considered when making diagnoses. That is, many typically developing individuals may present with ASD-like symptoms at some point during their development. That does not mean that their symptoms will be pervasive in nature or will go on to impact their day-to-day functioning (Wallace, 2014).

### 1.3.3. Summary

A popular adage in some autism communities is that if you have met one person with autism: you have met *one* person with autism. Diagnostic criteria have always been present;

however, the unique interaction between each criterion is something that cannot be concretely captured. As Wing puts it (1988; paraphrased and cited in Adams, 2011), “a spectrum disorder is not simply a continuum from more to less severe cases of a common deficit or set of deficits; rather, autism is a complex disorder better conceptualized in terms of combinations of various symptoms than as a unified syndrome” (p. 235). There is a great degree of variability between individuals on the autism spectrum, and Adams (2013) recommends caution and sensitivity when approaching ASD. The potential combinations presented from diagnostic criteria alone should be indicative of the highly variable nature of the disorder. As a result of this, it is rare to identify a deficit that will universally manifest in this population. Approaching ASD in a manner that strips it of its qualitative dimensions lends to the development of incorrect stereotyped representations which rarely mirror the estimated 1% of the population that are affected by this disorder (APA, 2013).

For the purposes of this chapter, autism will be identified and defined as a pervasive developmental disorder (APA, 2000) within the autism spectrum, displaying early signs in the first two years of life (APA, 2013; Kanner, 1943), with biological (Asperger, 1944; APA, 2013; Kanner, 1943), neurological (Kennedy & Courchesne, 2008) and potential environmental underpinnings (APA, 2013; Dover & Le Couteur, 2006), affecting the developmental trajectory of language (Asperger, 1944; APA, 2013; Kanner, 1943), learning (Asperger, 1944; APA, 2013), and social interaction (APA, 2013; Baron-Cohen, Leslie & Frith, 1985), as marked by a diminished ability to predict and navigate the social world (Kievit & Geurts, 2011; Sinha et al., 2014).

#### ***1.4. Theories***

There are three major theories attempting to explain the deficits in ASD: (1) Theory of Mind Thesis (i.e., mindblindness; inability to infer and attribute mental states to others), (2) Weak Central Coherence Thesis (WCC) (i.e., an overwhelming tendency towards detail, thereby missing the “big picture”), and (3) Weak Executive Function Thesis (WEF) (i.e., difficulty planning, organizing, and prioritizing tasks/activities) (Barnbaum, 2008). While each of these theories capture a few of the documented ASD deficits, not one of them has managed to present a paradigm that encompasses all of the potential challenges for individuals managing an ASD diagnosis. In the same manner that IS, SA, and ToM interplay in the development of social cognition, it appears that these theories attempting to encapsulate the deficits in ASD also have an intertwined relationship. When exploring ASD in relation to ToM and SA, it is worthwhile to acknowledge the existing tension between the ToM, WCC, and WEF theories. The Theory of Mind Thesis, however, has been argued to be “a core and possibly universal abnormality” (Baron-Cohen, 2000, p. 3) for individuals with ASD. In fact, ToM deficits are thought to be so pronounced in ASD that “mild degrees of mindblindness” have been noted in parents of individuals on the spectrum (Baron-Cohen, 2000 as cited in Barnbaum, 2008).

Kievit and Geurts (2011) suggested that “difficulties in predicting the behaviour and (emotional) content of others are thought to be a central aspect of the social difficulties seen in people with ASD” (p. 119). As more and more research in this area reveals, the social deficits of ASD are just as central to the diagnosis as the intellectual or physical limitations. Dover and Le Couteur (2006) address this point by highlighting that labels such as “high functioning” may speak to intact cognitive abilities; however, these descriptors do not capture the social deficits that may bear greater impact on the day-to-day functioning of individuals



diagnosed as such. Yirmiya, Erel, Shaked, and Solominca-Levi (1998) best framed this by stating that ASD deficits are founded in "the most complex of all human behaviours: communication and social interactions" (p. 305).

Sinha et al. (2014) present new evidence to substantiate the above. ASD individuals lack the ability to predict the physical and social worlds, thereby resulting in the observed insistence on sameness, sensory hypersensitivity as well as impaired ToM abilities. This theory has managed to encompass and organize features of all the WEF, WCC and ToM theories by examining these combined deficits through a new lens.

### ***1.5. Comorbidity***

ASD is a syndrome that is known to be associated with several other biological and mental health conditions (APA, 2013). Despite this, research examining this area of the diagnosis has been limited (Matson & Nebel-Schwalm, 2007). Conducting research in this area while accounting for potential confounds can be difficult. At one point, there were several subtypes of ASD, and over 60% of this population also appeared to have some form of cognitive delay. Intellectual disability is now thought to affect about 45% of individuals with ASD (Fombonne, Quirke & Hagen, as cited in Lai et al., 2014). Tsai (1996) also notes that assessment for many conditions relies on the use of verbal self-reported measures. Some mental health professionals may be disinclined to administer these self-report measures to lower functioning and/or nonverbal individuals. Furthermore, research examining the relationship between "core" autistic symptoms and comorbid conditions is rare.

About 30% of individuals with ASD also present with seizure disorder, between 2-5% present with Fragile X Syndrome, and an additional 1-3% present with tuberous sclerosis (Tsai, 1996). Twelve to 17% of individuals with ASD will also present with catatonia (Kannabiran & McCarthy, 2009). Seventy percent of individuals examined in Simonoff and colleagues' (2008) study had at least one associated comorbid condition, and 41% presented with two or more comorbid conditions. Social anxiety disorder, attention-deficit/hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD) were found to be the most commonly associated conditions. Overall, comorbidity was found to be much more common within the ASD population than many other studies had previously estimated (Simonoff et al., 2008).

White, Oswald, Ollendick, and Scahill (2009) conducted a study evaluating research in the area of ASD and anxiety. Looking back at both Kanner (1943) and Asperger's (1944) case-studies, they found many references to anxious tendencies within the behaviour patterns of the individuals examined. Between 11-84% of individuals with ASD present with some form of anxiety. Treatment options are available, but it appears as though success has been limited, as many treatment approaches have only been documented in case-studies, thereby restricting generalizability (White et al., 2009).

Matson and Nebel-Schwalm (2007) indicate that there is evidence for depression, bipolar disorder, phobias, obsessive-compulsive disorder (OCD), anxiety, and schizophrenic presentations, as well as tic disorder and Tourette's Syndrome (Kannabiran & McCarthy, 2009) in ASD. Alexithymia, a condition affecting the ability to identify and describe emotions in the self, has also been noted to be highly prevalent in ASD groups (Lombardo et al., 2010). Diagnostic tools appropriately tailored to assess these deficits within the ASD population do not exist (Matson & Nebel-Schwalm, 2007). That is, current diagnostic measures are meant to examine these conditions in typically developing populations and may

not be sensitive or valid in detecting these syndromes, if symptomatology presents differently for the same conditions, in clinical populations.

### ***1.6. Neuroanatomy***

Kennedy and Courchesne (2008) examined brain connectivity (i.e., the causal interactions between brain structures as monitored by blood oxygenation level dependent signals) in typically developing and ASD diagnosed individuals. Specifically, they examined the Task-Positive Network (TPN) (i.e., the network activated during the performance of external cognitive tasks such as math), and the Task-Negative Network (TNN) (i.e., the network activated during social, emotional, and self-referent tasks). Individuals with ASD had significantly reduced neural connectivity in the TNN, while connectivity in the TPN did not differ from the control group. Additionally, TNN connectivity seemed to be most impacted by altered functioning of the MPFC and left angular gyrus. Monk et al. (2009) also found that brain connectivity for individuals with ASD was weaker between the right temporal lobe and the right parahippocampal gyrus, as well as the superior frontal gyrus and the posterior cingulate cortex. The latter set of these two structures provide additional evidence of neurological underpinnings for the social functioning deficits noted in ASD.

Lombardo et al. (2010) found that in ASD diagnosed individuals, reduced activity of the middle cingulate cortex during self-mentalizing conditions indicated atypical neural self-representation. In neurotypical populations, activation during self-mentalizing (i.e., SA) conditions is usually increased. Ventromedial prefrontal cortex activation was also found to remain the same during two conditions (i.e., self versus other judgments), while current evidence indicates increased activation for self versus other scenarios (see 3.1.2). Further analysis examined brain activation alongside symptom severity as measured with the ADI-R. Individuals who were less socially impaired during their childhood had greater vMPFC activations overall than those who were greater impaired socially during their childhood (Lombardo et al., 2010). Finally, Lou (2011) found that individuals with ASD had a dysfunctional paralimbic network of SA.

From these studies, it is evident that brain structures and neural connectivity in the ASD brain differs from the typical population. As Machery states (2011, cited in Adams, 2011), “brains areas are massively interconnected, so that developmental changes in one of these areas have consequences in numerous other areas. As a result, even minor developmental brain problems have cascading effects, which affect the development of the whole brain and of all cognitive capacities” (p. 765). In ASD these differences are present in a number of brain networks, ultimately affecting the overall developmental trajectory of social cognition for individuals with an ASD diagnosis.

### ***1.7. Development and Real-World Outcomes***

Individuals on the spectrum are more likely to encounter abuse (i.e., sexual and social bullying) than their neurotypical counterparts (Brown-Lavoie, Vecili & Weiss, 2014; Chan & John, 2012; Sevelever, Roth & Gillis, 2013; Simone, 2010). In regards to both sexual abuse and bullying, ToM deficits, coupled with an overarching limited understanding of social norms and sexuality have been posited as potential mediating/causal factors. Sevelever and colleagues (2013) have noted that individuals with ASD are also overrepresented in correctional facilities, but data is not accessible to determine the crimes committed. Many individuals on the spectrum are prone to cybercrime due to their limited social skills and

exceptional computer abilities (Wallace, 2014). de Vries, Noens, Cohen-Kettenis, Berckelaer-Onnes and Doreleijers (2010) have additionally noted that ASD diagnosed individuals are overrepresented in gender identity clinics. The results from this study highlight the potential underlying deficits pertaining to agency (i.e., sexual identity), as well as draw attention to potential difficulties that individuals with ASD may encounter as they work towards developing a self-concept.

Mukaetova-Ladinska, Perry, Baron, and Povey (2012) discuss the limited attention that ASD lifespan development has garnered in the literature. On PubMed, there are close to 180,000 studies examining ASD. Of those studies, a little over 120,000 examine ASD in childhood. Less than 6,000 of those reports are focused on ASD in adolescence and even fewer still examine ASD in adulthood. To date, there are less than 10 studies examining ASD in the elderly. This is an area that is highly underdeveloped in the literature and greater attention needs to be dedicated to developing strategies to assist the estimated 1% of the population managing this diagnosis (Happé & Charlton, 2011).

Individuals with ASD further appear to be underemployed and underpaid (Roux, Shattuck, Cooper, Anderson & Narendorf, 2013). When they do find work, they may be prone to bullying or sabotage (Simone, 2010). As a result, many will continue to require some degree of support throughout their lives (Happé & Charlton, 2011). Woolfenden, Sarkozy, Ridley, Coory, and Williams (2012, as cited in Lai et al., 2014) also note that individuals on the spectrum have a mortality risk that is two to eight times more likely than the typically-developing population. This elevated risk is mitigated in part by some of the comorbid health conditions which individuals on the spectrum are more prone to.

## **2. Self-Awareness in Autism Spectrum Disorder**

### ***2.1. Self-Concept***

Frith and Happé (1999, as cited in Williams, 2010) and McGeer (2004) put forth the notion that individuals with ASD may have as limited a view of their own mental states as they do of others' mental states (i.e., ToM). Self-awareness however, encompasses more than awareness of internal mental states (see 1.1.1). Research on SA deficits in ASD carries heavy philosophical implications (Barnbaum, 2008) and overall seems to provide mixed results. Due to the inconclusive and inconsistent nature of findings in this area, coverage in this section will be limited to highlighting key areas.

Lee and Hobson (1998) found that individuals diagnosed with ASD performed as well as controls when answering questions from the Self-Understanding Interview developed by Damon and Hart (1988). That being said, performance on the social category of this measure differed significantly from the control group. This indicated a seemingly intact self-concept but highlighted that relation to others may be compromised (i.e., ToM). Verhoeven et al. (2012) found that individuals with ASD who had greater SA at the start of a specialized treatment program fared better on clinician and parent reports of social functioning after one year than those who did not. ASD diagnosed individuals with increased SA also were found to report more daily and psychological problems over the one year specialized treatment program. As noted in Part 1 of this chapter, SA can include self-reflection or self-rumination. Given the high incidences of comorbid psychiatric conditions in this population, it is possible

that SA in ASD diagnosed individuals may be more focused on areas of deficit (i.e., self-rumination) rather than areas of competence (i.e., self-reflection).

### ***2.2. Self-Reference Effect and Autobiography***

Toichi et al. (2002) explored the “self-reference” effect in ASD diagnosed individuals and matched controls. The self-reference effect is the notion that encoding information in a manner that is personally relevant tends to lead to greater recall. Individuals with ASD did not benefit from the self-reference effect when encoding information, potentially indicating a deficient self-concept. Much like the self-reference effect, it has been found that episodic memories (i.e., personally experienced events) are better recalled than semantic memories (i.e., facts, dates, etc.). Williams (2010) reviewed a study conducted by Bruck et al. (2007) in which individuals with ASD were asked to recall memories from their childhood, with parents either confirming or denying these memories. Individuals with ASD produced fewer parent-verified utterances than the control group.

From these studies, it appears that on some level using the self as an anchor for experience is impaired in autism. But is that really a deficit? McGeer (2004) highlights that there are many incredibly detail-oriented autobiographical accounts written by individuals on the spectrum. The writings produced by these individuals tend to focus on different stimuli. That is, their experiences appear to be shaped by overwhelming sensory experience, rather than social encounters. The Saliency Landscape theory (Ramachandran & Oberman, 2006, cited in Barnbaum (2008) precisely suggests that heightened responses to sensory stimuli impede social interaction in ASD.

### ***2.3. Self-Development***

As discussed in Part 1, section 1.3.1, SA is theorized to follow a certain developmental trajectory (i.e., use of personal pronouns, pretend play, mirror self-recognition, etc.). On some level, this route appears to be interrupted and/or inconsistently present in the ASD population. Researchers theorize that this “interruption” to social interaction is sensory based (Barnbaum, 2008). As more time is spent managing the physical world, less time is spent interacting with the social world, potentially impacting the development of self. Varga (2011) discusses pretence (i.e., pretend play/exchange) in the development of self as well as in understanding others. For example, childhood pretence is practice for like-adult interactions (i.e., games, culture, religion, etc.). Thus, if one does not actively engage in one or more of these “developmental steps,” a concept of self and self in relation to others, may be impaired.

Furthermore, impaired use of language (i.e., pronoun reversal) is so prevalent in the ASD population (see Kanner, 1943; Asperger, 1944) it may provide further evidence towards impaired SA. Gidley Larson and Suchy (2014) examined the use of self-directed speech as ASD individuals performed motor sequencing and control tasks. Relative to the control group, ASD diagnosed individuals were not impacted by task-incongruent verbalizations. On the other hand, when prompted to use task-congruent verbalizations, individuals with ASD improved their overall performance more than the control group. See Part 3 of this chapter for greater discussions of IS and its role in ASD diagnosed groups.

#### ***2.4. Use of Mirrors and Video Recordings***

Using mirrors and joint-attention, Duff and Flattery (2014) implemented a treatment program that focused on the development of mirror object identification, mirror self-identification and mirror self-recognition (MSR) over a four month period. Through continued practice and exposure, six individuals with an ASD diagnosis “progressed” through stages towards MSR. Increased time with mirrors was also found to positively impact the overall time spent focused on assigned tasks (i.e., 5 minutes at the start of program to a high of 80 minutes during the program).

One of the current authors has observed that ASD diagnosed individuals who were recorded on video as they engaged in common social exchanges used the opportunity to observe themselves in a different light, making comments such as “is that what I really sound like?” and “do I really do that?” By self-recognizing and identifying potential areas of improvement, increased efforts were noted to “correct” these areas. Research using video recording techniques with ASD populations is limited; however, this is a potential area of therapeutic intervention to increase SA and improve overall interaction with others.

#### ***2.5. Summary***

Much of the literature examined for this chapter exploring SA in ASD was found to be theory-focused/based. As noted earlier, this theoretical lens provides a certain degree of separation in which ASD individuals and the typical population never see eye-to-eye. As Barnbaum (2008) puts it: “the gulf between persons with autism and those without autism seems wider and wider when it becomes clear that persons with autism cannot understand those without autism, and those without autism cannot understand what it would be like to have autism” (p. 46).

### **3. Theory of Mind in Autism Spectrum Disorder**

#### ***3.1. Representative Studies***

Baron-Cohen et al. (1985) explored whether ToM deficits presented more-so in individuals with ASD than two control groups: one with a Down's Syndrome diagnosis, the other neurotypical. The Sally-Anne False-Belief Task was administered to all participants, followed by four questions as identified in the study: "naming," "belief," "reality," and "memory."

The "naming question" was meant to determine whether or not participants were able to distinguish between the two dolls. The "belief question" was used to determine if participants could accurately identify where Sally would look for the marble, even after Anne had moved it while Sally was out of the room. The "reality" and "memory" questions served as controls. That is, if individuals were able to accurately identify where the marble really was (i.e., reality question), and where the marble had been at the beginning of the scenario (i.e., memory question), then the deficit presented was not perceptual in a logistic or visual-spatial sense, rather it was perceptual in regards to ascription of mental states (Baron-Cohen et al., 1985).

Results revealed that all participants successfully passed the naming, reality, and memory questions. In regards to the belief question, 23 of 27 neurotypical children, and 12 of 14

children with Down's Syndrome passed. Conversely, only 4 of 20 children with ASD passed the belief question—a significant difference between the groups. Children with ASD “fail to employ a theory of mind” (Baron-Cohen et al., 1985, p. 43). By including a control group of individuals with Down's Syndrome, cognitive abilities and intellectual capabilities were controlled for. That is, intellectual delays alone could not account for the group differences observed in this study. Therefore, the deficit noted in regards to ToM was distinctly an ASD deficiency.

Yirmiya and colleagues (1998) conducted a meta-analysis examining ToM abilities in individuals with ASD, intellectual delay, and typically developing controls. Different ToM tasks appeared to measure different components of ToM and relied on a combination of abilities rather than a distinct ToM skill-set. This, in turn, affects the overarching reliability of these measures as well as their implementation as tools of ToM assessment. With respect to actual ToM tasks, it appeared as though some relied on linguistic abilities and others relied on more cognitive or emotional skills. This further underscores the inconsistency in what the examined ToM tasks *actually* measured.

Results from the meta-analysis revealed that overall, a ToM deficit presented itself more in groups with ASD than those without (Yirmiya, Erel, Shaked & Solomonica-Levi, 1998). Those difficulties were also more profoundly present with older individuals managing an ASD diagnosis than typically developing children. Some individuals with ASD can be much older chronologically than their presented mental age and many of the studies explored only presented the mental age (MA), excluding chronological age (CA). IQ measures are adaptable to an extent; however, they cannot account for the experience garnered by CA. As a consequence of this, results from the studies included in Yirmiya and colleagues' study may be impacted by the discrepancy of “experience” between CA and MA.

Baron-Cohen, Jolliffe, Mortimore, and Robertson (1997) administered a combination of ToM tasks (the Eyes Task and the Strange Stories task) and control tasks to three groups of individuals: one group with ASD, one group with Tourette's Syndrome, and a control group of typically developing matched controls. The ASD group contained individuals with average to above average IQs; however, they still performed poorly on the subtle ToM tasks. Females overall performed better than males on the Eyes Task. This captured a postulated sex bias in mentalizing abilities which other tools of assessment had been unable to isolate.

### ***3.2. Advanced Theory of Mind Abilities***

Advanced ToM abilities were examined in children and adolescents with ASD (Scheeren, de Rosnay, Koot & Begeer, 2013). Performance was found to be mediated by age, verbal, and general reasoning abilities. Although the ASD sample performed relatively comparable to the control group, their functional ToM abilities in everyday life seemed to still be impacted by their ASD diagnosis. Siller, Swanson, Serlin and Teachworth (2014) also found that ASD diagnosed individuals were less likely than controls to reference the internal states of characters when developing the plot of wordless storybooks. This study provided additional support to the notion that some ToM abilities are dependent on age, as well as language use. The number of affective terms coupled with the overall volume of language used to describe the storybooks revealed a distinct deficit in the ASD sample.

### ***3.3. Everyday Theory of Mind Abilities***

Everyday ToM abilities of individuals on the ASD spectrum were explored based upon teacher and/or caregiver reports (Frith, Happe & Siddons, 1994). This was done by administering two ToM tasks (the Smarties test, and the Three Boxes test) to individuals with an ASD diagnosis, alongside two control groups. Performance on these tasks was compared to reports from the Vineland Adaptive Behaviour Scales (VABS) as completed by a caregiver or teacher. For the ASD group, individuals who passed ToM tasks seemed to exhibit more social insight, but not more simple sociability. Language was also found to play a mediating role. In the ASD group, individuals who successfully passed ToM tasks also possessed greater language abilities than those who failed. From this, it is possible to hypothesize that individuals who performed well on ToM tasks did so as a result of advanced language skills, rather than actual mentalizing abilities (Frith et al., 1994).

Further evidence for real-world ToM abilities in ASD was drawn from naturalistic observations conducted at participants' residences (Kremer-Sadlik, 2004). Sixteen individuals with ASD were observed at dinner time with their families, and their conversations were coded based upon adequate, ignored or inadequate responses. Parents and other family members indirectly coached the participants towards more appropriate social exchanges by providing context, initiating conversations around topics of interest for the individuals with ASD, and repeating/re-framing questions to elicit appropriate responses (Kremer-Sadlik, 2004). If some of those with ASD can infer context through indirect social coaching, then this provides support for some ToM abilities some individuals with ASD.

### ***3.4. Levels of Theory of Mind***

There has been a trend in ToM literature towards modularity (see Scholl and Leslie, 1999). Theory of mind deficits in ASD have since either been identified as lower or higher-level, further isolated based upon domain-specific or domain-general systems. Lower-level deficits such as facial and eye gaze have been studied in a number of ways. To illustrate, Zwickle, White, Coniston, Senju, and Frith (2011) recorded eye movements as ASD and control groups watched short films known to elicit mentalizing. There were no group differences for the actual perception of events in the short films: individuals with ASD had intact lower-level processing in regards to agency perception and visual perspective taking. It thus appears as though these lower-level processing systems are intact in ASD (Adams, 2011). Theories of lower and higher levels of social navigation are discussed in Part 3, section 3.2.

## **4. Issues in Reviewed Research**

### ***4.1. Overview***

The literature reviewed for this section presented a few issues. Specifically, sample sizes, inclusionary/exclusionary criteria, comorbidity and medication use, as well as the administration of diagnostic measures are discussed below. While some of the mentioned studies controlled for these variables, a larger number did not. It is also important to note that the overall trend from recent studies seems to be moving towards correcting some of these identified areas.

#### **4.2. Sample Size**

Diagnostic rates for ASD in the DSM-III were 2 to 4 cases per 10,000 individuals (APA, 1980). In this respect, it may have been challenging in the 1980s to gather large samples of ASD diagnosed individuals. Larger samples lend to greater statistical power, increasing confidence, and overall generalizability of results (Cozby, 2009). Prevalence rates for ASD are now at an estimated 1% of the population (APA, 2013); however, samples sizes for studies examining ASD deficits have not been reflective of this increase. That is, many of the studies examined in this section are still using small samples (i.e., less than 25 individuals). While many of the studies acknowledged their small sample sizes, after 30 years' worth of studies, it is not enough to simply identify a small sample: it is imperative that efforts are made to examine larger samples. It was also observed that many of the studies reviewed did not include individuals who were nonverbal. As noted earlier, it is estimated that 25% of individuals on the spectrum are nonverbal and excluding this subset of the ASD population further limits the conclusions that can be drawn from any of the obtained results.

#### **4.3. Comorbidity**

In regards to comorbidity, there is evidence to suggest that ToM and SA are impaired in other clinical populations (see Ali & Chamorro-Premuzic, 2010; Philippi & Koenigs, 2014; Richell et al., 2003; Shamay-Tsoory, Harari, Peretz & Levkovitz, 2010). The neural networks affected in ASD are similarly impacted in schizophrenia and ADHD (Lou, 2011). Most of the studies examined did not explicitly mention comorbidity or any efforts to control for comorbid conditions. However, it is possible that some of the studies examined may have controlled for secondary diagnoses without stating so in their methodologies. Closely related to comorbidity is drug use. There are many drugs available to help manage some ASD symptoms (Lai et al., 2014). Many are also used in the treatment of comorbid conditions. Because many studies did not identify and control for comorbid conditions and/or medications, it is unclear whether the observed ASD deficits are wholly a result of ASD or if they are manifestations of the interactions between ASD and underlying comorbid conditions.

The study conducted by Monk and colleagues (2009) illustrates these points. Of 12 individuals with ASD sampled in this study, 11 were using psychotropic medications which included selective serotonin reuptake inhibitors (SSRIs), stimulants, neuroleptics, bupropion, tricyclics, and benzodiazepine. Medication use was isolated by type, and neural connectivity still remained altered for the ASD group versus the control group. Monk et al. (2009) highlighted that it would have been counterproductive to control for *all* medications, as the sample size for ASD diagnosed individuals was already small, and only one individual in that group was not on medication. However, had a larger sample been used, it is possible that there would have been a greater balance between individuals with and without medication, allowing for further investigation of the presented effects.

#### **4.4. Diagnostic Issues**

It was observed in a number of studies that diagnostic tools of assessment (e.g., ADOS, ADI-R, DISCO, etc.) were administered to the ASD groups to confirm diagnosis, but these same measures were not administered to control groups to confirm the *absence* of an ASD diagnosis. In this respect, it is possible that members of the control groups could have been on the spectrum, but undiagnosed. In fact, in Brown-Lavoie et al.'s study (2014), 24 individuals



from the control sample were excluded as their scores on the Autism Spectrum Quotient (AQ) exceeded the cut off. Bearing in mind, for some studies it would not have been feasible to administer these measures as they did not exist (\*), or results would not have impacted the study (+). See Table 4 for an overview.

**Table 4. Selection of articles examining sample size of ASD diagnosed individuals, acknowledgement of comorbidity and administration of ASD diagnostic measures to control groups**

Year	Authors	Name of Study	ASD Sample Size	Comorbidity Addressed	Controls Used
1985	Baron-Cohen, Leslie and Frith	Does the autistic child have a "theory of mind"?	20	No	No*
1994	Frith, Happe and Siddons	Autism and theory of mind in everyday life	24	No	No
1998	Lee and Hobson	On developing self-concepts: A controlled study of children and adolescents with autism	12	No	No
2002	Toichi, Kamio, Okada, Sakihama, Youngstrom, Findling and Yamamoto	A lack of self-consciousness in autism	18	Yes, controlled for medication and neurological problems	No
2008	Kennedy and Courchesne	The intrinsic functional organization of the brain is altered in autism	12	No, but controlled for medication	No
2010	Lombardo, Chakrabarti, Bullmore, Sadek, Pasco, Wheelwright, Suckling...	Atypical neural self-representation in autism	23	Yes, only Alexithymia	No
2010	de Vries, Noens, Cohen-Kettenis, van Berckelaer-Onnes and Doreleijers	Autism spectrum disorders in gender dysphoric children and adolescents	16	Yes	No+
2012	Verhoeven, Marijnissen, Berger, Oudshoorn, van der Sijde and Teunisse	Brief Report: Relationship between self-awareness of real world behavior and treatment outcome in autism spectrum disorder	19	Yes	N/A

Year	Authors	Name of Study	ASD Sample Size	Comorbidity Addressed	Controls Used
2013	Brown-Lavoie, Viecili and Weiss	Sexual knowledge and victimization in adults with ASD	95	N/A	Yes
2014	Siller, Swanson, Serlin and Teachworth	Internal state language in the storybook narratives of children with and without autism spectrum disorder: Investigating relations to theory of mind abilities	20	No	No
2014	Duff and Flattery Jr.	Developing mirror self awareness in students with autism spectrum disorder	6	No	N/A
2014	Gidley Larson and Suchy	Does language guide behavior in children with autism?	21	Yes	Yes

#### ***4.5. Terminology Issues***

Another potential issue worth noting is the high prevalence of terms used to identify the same or similar concepts. For example, when referring to ToM, terms such as mentalizing, metacognition, metarepresentation, and mindblindness tend to be used interchangeably. Self-awareness is no different, with additional terminology such as self-reflection, self-consciousness, theory of own mind, etc. There are nuanced differences between these terms, and the practice of using them interchangeably may create challenges as the more a concept is relabeled, the less distinct it becomes.

#### ***4.6. Intervention Strategies***

Finally, there is a small collection of studies exploring both SA and ToM deficits in ASD as covered in this chapter. Unfortunately, many of these studies did not provide potential intervention strategies or therapeutic techniques. Lai et al. (2014) detailed intervention approaches that have been used to manage ASD symptoms to-date. Success for most of these treatment options was low to moderate. Ozonoff and Miller (1995) explored one intervention approach to improve ToM abilities in an ASD sample. Their findings revealed that individuals with ASD were better able to pass false-belief tasks as a result of this program, but parent and teacher reports indicated no overall increases in social competence. White, Keonig and Scahill (2006) reviewed intervention research from 1985 to 2006 regarding social skill development in individuals with ASD. While there is some promising evidence for group-based social skills training, these results are preliminary. Overall, the interventions available are in need of revision and systemization to allow for empirical study and scientific dissemination.

## **5. Summary**

This Part presented evidence for deficits in both SA and ToM in ASD diagnosed individuals. There is conflicting support for both areas explored. For example, Williams (2010) reviews a series of studies that indicate bodily SA in ASD is intact. On the other hand, Duff and Flattery (2014) argue that individuals with ASD cannot be expected to complete daily living skill goals if they lack bodily SA; their paper is dedicated to examining that specific deficit in a small group of individuals with ASD. These findings are par for the course given the spectrum nature of ASD. However, rather than focusing on the universality of a deficit, energy should be invested in developing programs to target pockets of the ASD population. As discussed in Part 1 of this chapter, it is difficult to examine SA, IS, and ToM independent of one another. Research examining these areas and their intertwined relationship in ASD exists but is limited. Moving forward, it may be beneficial to examine the interplay of these theories in the ASD population.

Asperger (1944) highlighted the value of the “autistic psychopath.” He projected a positive existence for these individuals, one in which they contributed and came to be active members of their societies. As noted earlier in this section, research and overall attention to ASD is on the rise. There is arguably no better time to develop as well as implement strategies and support systems that provide ASD diagnosed individuals with opportunities to lead meaningful and fulfilling lives. Autism is a spectrum disorder: just as it is challenging to identify universal deficits for this condition, identifying universal intervention techniques will be just as challenging. However, as already mentioned, there is an imbalance in the literature when exploring ASD. Many studies have been aimed towards intervention for younger individuals, with very limited research available exploring the deficits in adolescents and adults, let alone intervention strategies. Further research needs to be dedicated towards first exploring the deficits and their development over the lifespan, then towards providing systematic intervention strategies to promote independence and overall successful functioning.

## **PART 3. INNER SPEECH AND THEORY OF MIND IN TYPICAL AND ASD INDIVIDUALS**

### **1. Overview**

The aim of this part of the chapter is to summarize the complex relationship between IS and ToM. In order to effectively do so now, we earlier argued for the role of IS in SA, the role of SA in ToM, and the potential role of IS in ToM (see Part 1, section 4). If there is a strong relationship between SA and ToM, and IS use is implicated in both SA and ToM, then investigating the link between IS and ToM is strongly warranted. It makes sense that intact SA and ToM may rely in part on IS, because one important way information about the self (SA) and others (ToM) is communicated to the self is by means of self-talk. Theory of Mind deficits in ASD have been largely focused on in the literature, and whether or not IS impairment is linked to ASD deficits is the focus of this part of the chapter. In our review we have found that understanding the relationships between SA, IS, ToM, and functioning in

typically developing individuals compared to those with ASD, is much more complex than asserting singular deficits. Multiple factors are at play—cognitive, neurological, developmental, social, environmental, theoretical, and methodological factors that all seem to affect the trajectory and study of SA, IS, ToM, and ASD.

### **1.1. Definitions of PS and IS**

Piaget (1923/1926) used the term *egocentric speech* to define overt speech for the self made by children who spoke aloud but who did not seem concerned with whether others understood them and did not adapt or direct their speech toward others. Private speech has been defined as overt speech for the self made by adults (Flavell, 1966), but has been studied as private speech instead of egocentric speech in children as well (Vygotsky, 1934/1962). Therefore we use the term *private speech* (PS) to refer to any overt speech for self in the presence of others or alone.

Inner speech (IS), or the activity of talking to oneself in silence (Morin, 2012), is also referred to as inner talk, self-talk, subvocal speech, mental verbalization, self-verbalization, internal monologue, internal dialogue, self-statements, covert speech, and auditory imagery, which participates in one's awareness of conscious experience (Morin and Uttl, 2013).

Observations of a developmental shift from PS to mostly IS (Vygotsky, 1987), as well as similarities between phenomenology and functions of PS and IS, have led some researchers to refer to these types of speech for the self together as *self-directed speech* (e.g., Lidstone, Meins, and Fernyhough, 2010). Taken together then, both PS and IS constitute running verbal commentary produced by the self, focused on the content of the self's subjective experience, and helps the self become aware of its experience (Morin, 2005; Morin and Uttl, 2013).

### **1.2. Theoretical Relationship between Language, PS and IS**

Morin (2012) reviewed theories of IS and emphasized Vygotsky's theory as the most complete and coherent view. This view can be taken as an account of multi-directional influences on cognitive development, with culture and language as potential factors. For example, culture affects children's cognitive development by providing the contents of thought and providing guidelines on how to think. Specifically, cognitive development is facilitated by a dialectical process involving social interactions (with parents, teachers, friends, etc.) to solve problems. Vygotsky suggested that children can solve some problems by themselves but need help from others to solve more complex problems. He termed the space between independent and dependent problem-solving the *zone of proximal development*. If social agents disrespect this zone by helping children when they do not need help or by not helping children when they do need help, then cognitive development may be impeded. Language is at the core of social interaction in the theory because it conveys information. Children's own language is gradually used as PS to solve their own problems and regulate their own behaviour. The process of *internalization*, or using an instrument of thought to perform similar functions, gradually emerges in later childhood in the form of IS. As for language, researchers have stopped asking if language causes thought or if thought causes language, but instead ask how language affects thought processes (Morin, 2012).

De Guerrero (2005) addressed the relationship between PS and IS in the context of Vygotsky's methodology. According to this account, Vygotsky inferred that it is possible to predict which characteristics of PS are related to characteristics of IS (e.g., retaining the abbreviatedness and ellipsis that is common to IS in comparison to more grammatically

complete PS), and which aspects may be only temporary (e.g., overt vocalization in PS which is not present in IS). Researchers have found that PS use typically decreases while IS use typically increases, with both changes occurring around age 7 (Williams and Jarrold, 2010), but that PS does not disappear *per se*, remaining very active throughout the lifespan (Fry, 2014; John-Steiner, 2014).

### ***1.3. Characteristics and Processes of PS and IS***

#### **1.3.1. Characteristics**

We may not be aware of our inner experiences (IEs) as we hurry through everyday life, moving from one task to the next (Hurlburt, Happe, and Frith, 1994). However, if we stop and pay attention to the moment of experience, we observe aspects of IE (Hurlburt, 1990) such as (1) *verbal inner experience* (IS), or verbal thinking expressed in inner words and sentences, (2) real or imagined *visual images*, or IE resembling visual experience of external stimuli (perception of distances, colours), (3) *unsymbolized thinking*, or clearly apprehended thoughts that did not consist in symbols carrying meaning (words, images, etc.), and (4) *feelings*, or emotions. We may also experience any combination of these IEs, some of us generally experiencing more of one IE than another. Hurlburt and colleagues (1990) used Descriptive Experience Sampling (DES; see Part 3, section 1.5.2), a detailed method for capturing IEs as close to the instance of occurrence as possible, on a wide variety of people including some with ASD (Hurlburt, Happé, and Frith, 1994). As far as we know there are no data-driven descriptions of specific IS characteristics in ASD available.

The main differences between typical characteristics of PS and IS are that PS is overt, involves more complete sentence use, and more accessible apprehension. An instance of both PS and IS may sound like one asking oneself, “Am I paying attention...?”. However, the internal aspect of IS has many distinct features from PS as outlined by Hurlburt and colleagues (2013): (1) internal apprehension, when one notices oneself speaking meaningfully without producing sound or noticeable body movement, (2) silent voice, or IS apprehended in one’s own voice with similar rhythm, pace, expressiveness etc., (3) likeness to speaking aloud, or an inability to differentiate between IS and overt speech except knowing that IS occurs internally, (4) conveying meaningful expression, such as emotion, curiosity, interest etc., (5) abbreviatedness, when IS may not always be heard in complete sentences, (6) same word use as would be used in overt speech, (7) direction of IS, as in toward the self or others (or sometimes unidentified), and (8) feeling of IS being produced but not heard.

#### **1.3.2. Processes**

One processing theory utilizes a cognitive systems approach, taking into consideration that the most frequent types of general IEs reported are IS and visual experiences (Engelbert and Carruthers, 2011). There is a large convergence toward the view that humans and non-human animals share a capacity for quick, automatic processing, termed the “*System 1*” (p. 6). Humans also have a capacity for a slower, more deliberate, less automatic processes involving working memory, visual, and auditory imagery (e.g., IS), called “*System 2*”. There is wide variation in the character and extent of System 2 use, therefore the authors argue it makes sense that some people may use IS most of the time while others use visual information most of the time.

There is great debate about the mechanisms responsible for the generation of types of processing in Systems 1 and 2 processing. The consensus is that IS requires at least a subset of the processes needed for PS production, but with uncertainty regarding what extent IS and overt speech production processes overlap (see Oppenheim and Dell, 2008; Corley, Brocklehurst, and Moat, 2011; and reply from Oppenheim, 2011). Some theorized components of IS are (1) *phoneme retrieval*, or access to the smallest known linguistic units that may bring about change in meaning, (2) *phonological processing*, or an auditory processing skill that involves detecting differences in phonemes, (3) access to *sub-phonemic* information such as speech sounds (e.g., featural, phonetic, and motoric information), and (4) *attenuation*, or distribution of inputs beyond processing involved in PS (definitions for terms used are supplemented with information from Clements, 1985).

Phonological processing involves more than detecting differences in phonemes. For example, it plays a role in the model of *working memory* (a multicomponent cognitive architecture involved in control of attention and manipulation of information), which originated from earlier studies of short-term memory (Hofmann, Friese, Schmeichel, and Baddeley, 2011). The model posits the *central executive* component (attentional control system) and three storage subsystems including the (1) *phonological loop*, which holds verbally and acoustically encoded information, (2) the *visuospatial sketchpad*, which holds visual and spacial information, and (3) the *episodic buffer*, which holds information by interfacing with long-term memory, the central executive component, and the other storage systems.

Subvocal speech (IS) is posited to be controlled by the phonological loop, which has multiple sub-components. The *phonological store* holds information in a verbal form for a short term, and the *articulatory control* (AC) process, which translates visual information into a verbal code in order to enter the store, and further rehearses the information to prevent decay (forgetting). In Williams et al.'s (2008) understanding, the recoding of information into verbal form and the rehearsal of this information is an example of IS. Interestingly, working memory is currently theorized to aid self-regulatory goal pursuit (see Hofmann et al., 2011 for a review), and IS (involving working memory) is strongly related to self-regulatory functions as seen earlier. Evidence for multiple processes and functions involved in IS shows us that IS plays a complex, yet key role in cognition, the study of which has advanced but remains murky.

#### ***1.4. Neuroanatomy***

To our knowledge, the assumption in fMRI studies is that PS and IS involve the same anatomy (Broca's area). The left inferior frontal gyrus (LIFG) is activated during overt and covert speech generation and self-related processing (Morin and Michaud, 2007; Morin and Hamper, 2012). Broca's area (involved in IS) includes activation in the LIFG and beyond. Researchers have also referred to the LIFG as the left ventrolateral prefrontal cortex or left frontal operculum, including Broadmann's areas 44, 45, and 47. Activation of the LIFG occurs when participants are asked to silently read single words or sentences, or when undertaking working memory tasks involving covert repetition of verbal material. Further, temporary disruption of the LIFG using repetitive transcranial magnetic stimulation, as well as accidental destruction of the LIFG, interferes with inner speech. Other brain areas are associated with IS use, among which are Wernicke's area, the supplementary motor area, insula, and superior parietal lobe on the left side, as well as right posterior cerebellar cortex

(Morin and Michaud, 2007; Morin and Hamper, 2012; for a thorough review of brain activation in IS, see Jones and Fernyhough, 2007). As mentioned in Part 1, 4.2, brain activation during completion of IS and SA tasks reveal overlapping areas of function, that is, IS use is often observed during SA tasks (Morin and Hamper, 2012). We predict that such an overlap will also be noted for IS and ToM tasks, where IS processing will be frequently reported during ToM task completion.

### ***1.5. Sampling Methods and Measures of PS and IS***

From a methodological perspective, it is impossible to directly access and therefore measure IS, but Vygotsky gave us the tools needed to reconstruct IS through a developmental and methodological merger (DeGuerrero, 2005, p. 91). Vygotsky built IS research methodology from two basic premises, that (1) IS is inaccessible to direct methods of observation, and (2) egocentric speech (PS), as a developmental predecessor of IS, is directly observable and measureable. Therefore, Vygotsky argued that the link between PS and IS use is strong enough to warrant analysis of PS as a gateway to IS (Vygotsky 1986 as in DeGuerrero 2005).

Tools used to measure and describe PS and IS include video cameras, diaries and logs, notes to self, random experience sampling, questionnaires, and fMRI scans of brain activity during self-talk.

Table 5 outlines the main methods used in IS research, including questionnaires, open-ended thought listing, phonological similarity and articulatory suppression effect sizes (PSE and ASE), providing a brief outline and example of each method. The many methods used to capture PS and IS lead us to consider methodological issues (see Part 3, section 5), and to conclude that different tools may be tapping into different aspects of IS (for different aspects of IS, see Part 3, 1.3 and 1.6).

#### **1.5.1. PS Measurement**

De Guerrero (2005) outlines the various methods of measuring IS in detail, starting with the study of PS. Researchers use video and audio recording (cameras, wireless microphones) to study oral aspects of PS, but few researchers study written forms such as private writing, introspective writing, and inner speech writing. Those who do study the written forms have been specifically interested in the physical qualities, regulatory functions, contents, and features of PS writing. For example, the form of the grocery list, the note to self to be addressed further later, or the personal wishes expressed in self-directed writing are commonly studied. Another method of study is *verbal reports*, or the data in which the source of information is the participant's own statements about their IS. *Introspective* (recall thoughts during instance) and *retrospective* (recall thoughts some time after instance) verbal reports of PS and IS can be coded into *self-reports* (what one thinks they say or do), *self-observations* (what specific actions or events occurred), and other overt verbalizations of an introspective nature occurring without analyzing or editing instance.

**Table 5. Main IS questionnaire measures including description and source information**

Questionnaire Measures	Description of Method	Authors
Inner Speech Report (ISR)	Open-ended self-reports used to cross-examine validity of IS questionnaires; frequency, content and function coded e.g., “What do you talk to yourself about, when and why?”	Uttl, Morin and Hamper (2012)
Varieties of Inner Speech Questionnaire (VISQ)	Dialogic IS, condensed IS, evaluative/motivational IS, and other people involved in IS measured using a Likert scale to rate the probability that a predetermined instance of IS applied to them, with one reverse coded item i.e., “I think to myself in words using full sentences”	McCarthy-Jones and Fernyhough (2011)
Self-Verbalization Questionnaire (SVQ)	Self-talk use aloud (PS) and subvocally (IS) measured using 27 items rated on a Likert scale assessing degree of agreement e.g., “I sometimes verbalize my thoughts when I’m working on a difficult problem.”	Duncan and Cheyne (1999)
Self-Talk Scale (STS)	Measuring PS and IS across behaviours and situations using both 22 and 16 items rated on a Likert scale to assess frequency e.g., “I talk to myself when I should have done something differently.”	Brinthaup, Hein and Kramer (2009)
Self-Talk Inventory (translated; STI)	Negative and Positive Self-Talk Scales rating probability of given IS statements in 10 given situations using 52 items on a Likert scale; e.g., imagine “They just tell you that you passed the exam you took last week” and rate how likely you are to say each of the 52 statements to yourself, e.g., “I’m cool”	Calvete et al. (2005)
Inner Speech Scale (translated; ISS)	Frequency of IS about the self using degree of agreement with 22 items on a Likert scale; e.g., “If I am not feeling well, I often talk to myself about my state”	Siegrist (1995)
Coding in Social Skills Training Programs (SSTP)	Coding verbalizations in social interactions (i.e., initiating, responding, other) during social behaviour and cognition training programs (SSTPs); verbalizations coding can include self-talk	Furrow (2014)
Presence or absence of articulatory suppression effect (ASE)	Articulatory suppression (AS) is when participants are asked to recite verbal information while doing tasks (e.g., recall) to assess whether performance relies on IS; IS cannot work if interrupted by AS	Richardson and Baddeley (1975)
Phonological similarity effect (PSE)	The larger the PSE, the more IS is assumed to be involved; the higher the ASE the more IS is assumed to be involved	Morin (2013)
Tower of London planning task	Assesses the effect of AS on planning  An effect of AS on self-directed speech (inner and private) supports the role of self-directed speech in planning	Shallice (1982)



The most recent advancements in PS research have used social speech as a control to PS in order to examine the developmental shifts in functions of PS. Furrow (2014) used a longitudinal design examining children's social speech and PS while interacting with mothers and experimenters (social speech control), finding the use of a social speech control imparitive to the study of PS. For example, utterances were classified into social speech context categories (eye contact or other social markers) compared to PS context (no social markers), which is possible because PS is used in social settings. Utterances were further coded according to previously justified functions such as engaging-regulatory, self-regulatory, expressive, referential, describing own activity, seeking information, imaginative, and informative, and informative. The results of this study suggest the useful functions of PS throughout situations.

### **1.5.2. DES: Descriptive Experience Sampling**

Descriptive experience sampling (DES; Hurlburt, 1994) is designed to capture and describe "high fidelity" (Hurlburt et al., 2013, p. 5) phenomenological characteristics of typical every day inner experiences (IEs), with more emphasis on accurately understanding and describing phenomenon than on establishing the precise apprehension of specific IEs *per se*. Hurlburt and colleagues (2011; 2013) argue that DES is the least distracting of the introspective methods because it is designed to teach participants to capture their experiences as automatically and unobtrusively as possible at the time of the instance. Participants are asked to carry a beeper throughout the course of the day, and to immediately respond to the beeper by attending to whatever was present in inner experience at the moment of the beep, then writing down notes about that experience.

The DES sampling method is much more rigorous than previous methods, involving participants collecting 6 random samples of IE per day, attending expositional interviews with investigators within 24 hours of collecting an IE (to collaborate on developing high fidelity samples), and repeating the procedure for 3 to 8 consecutive days. The high fidelity of the IEs is developed through "iterative" (Hurlburt et al., 2013, p. 5) repetition of the work by the participants and the investigators, including training to bracket presuppositional biases, to recognize and interpret IEs, and to use a common lexicon for communicating about IEs. These can be coded according previously described types of IEs (IS, mental imagery, unsymbolized thinking, emotions, and perhaps sensations; Hurlburt, 1990; Hurlburt et al. 1994).

### **1.5.3. Random Thought Sampling and Retrospective Thought Listing**

Morin and colleagues (Morin, Uttl, and Hamper, 2011; Uttl et al., 2012; Morin and Uttl, 2013) argued that sampling techniques can target specific aspects of consciousness, suggesting specific assessment of IS independent of other IEs. In order to tap typical IS use on a day to day basis, Morin et al. (2011) used an open-format thought listing technique to sample 400 undergraduate students, asking them to retrospectively list as many occurrences of IS as they could remember having in their everyday life. While this technique is effective for assessing the frequency and general content of typical IS use, Morin and Uttl (2013) noted that the method may have been susceptible to recall errors due to the retrospective nature of IS to be recalled, and the reconstructive nature of memory recall. De Guerrero (2005) also noted that IS may be incorrectly reconstructed or recalled because of the time elapsed between the experience and the report of the experience.

With these considerations in mind, Uttl et al. (2012) collected data using cell phones as a beeper prompt and asked 160 participants to immediately report whether they were talking to themselves, what they were talking to themselves about, and what activity they were engaged in. The researchers found that results from the retrospective thought listing technique (Morin et al., 2011) were comparable to results from the beeper prompt study (Uttl et al., 2012), and that IS was reported to occur about 50 % of the time, suggesting much more IS use than the previously reported. Hurlburt et al. (2013) argued that retrospective questionnaire methods contribute to participants' over-estimation of frequency of IS, and that when one captures IEs with DES, the frequency of IS occurrence declines. Hurlburt and colleagues suggested that other researchers should study the relative frequencies of IS in typical populations across cultures, and Morin and Uttl (2013) also suggested sampling of IS in other populations (e.g., older, non-university, clinical), and to consider individual differences (e.g., personality, prospective memory, verbal knowledge).

#### **1.5.4. Smartphone Technology**

The most recent experience sampling researchers have taken advantage of smartphone technology to further address small sample sizes. For example, Killingsworth and Gilbert (2010) created a web based application for the iPhone, randomly asking participants how they felt, what they were doing, and if they were thinking about something other than what they were doing. This method resulted in a large database (in 2010 a quarter of a million samples from 5000 people in 86 countries) of real-time mind-wandering experiences, showing that people's minds wander frequently, that is, 46.9% of the time. The researchers noted that this frequency is much higher than results from experimental laboratory studies. People's minds often wandered to everyday activities of life associated with feeling good, but that people generally felt worse when mind-wandering than when focusing on a current activity.

Smartphone technology could be developed to investigate the content, role, functions, and affective associations of IS in mind-focusing versus mind-wandering, with IS coded as for self and for others. Borrowing from Hurlburt (2013) as well as Killingsworth and Gilbert (2010), participants could be briefly trained to recognize instances of IS for self and others using a web based application before being sampled (for a thorough review of psychology research using smartphone technology, limitations, and suggested advancements, see Miller, 2012).

#### **1.5.5. fMRI**

Literature is starting to emerge on the neural correlates of IEs, and some researchers put emphasis on capturing IEs with as little sampling interference as possible. For example, in an integration of introspective and fMRI methods, Kühn, Fernyhough, Alderson-Day, and Hurlburt (2014) used fMRI to scan brain activity during IEs from one participant who was trained using the DES method described earlier (see Part 3, section 1.5.2). The study made use of 4 procedural phases simultaneously incorporating both DES and fMRI: (1) introduction to fMRI and DES methods as well as undergoing baseline scans (normal activity) and scans during elicitation of imagination (activity during task), (2) DES training consisting of wearing a beeper in the natural environment and jotting down IEs at time of beep with later interviews about experience, as per DES methodology, (3) in-scanner DES involving responding to the beep and recording IEs on a notepad that was positioned to not cause head movements in the fMRI scanner, followed by a DES interview, and (4) a post-

DES resting state fMRI scan. DES in the scanner activated LIFG processing that is associated with IS. These results provide support for the validation of both DES and fMRI methods of investigating IEs, but the researchers further reported that distinctions between IS and inner hearing, as well as prompted versus unprompted IS, need further investigation due to the limited sample size in the study.

## ***1.6. Content and Functions***

### **1.6.1. IS**

Participants report using IS frequently (i.e., Morin et al. 2011; Uttl et al. 2012), specifically focusing on self-related topics (self-evaluation, appearance, performance, others related to the self, others' evaluations of the self, activities related to the self). Inner speech plays a strong role in self-monitoring (Jones and Fernyhough, 2007; Perrone-Bertolotti, Rapin, Lachaux, Baciú, and Løevenbruck, 2014), self-reflection (Morin, 2011), and self-regulation (Vygotsky, 1943/1962). Executive functioning is facilitated by IS in such tasks as problem-solving, task-switching performance, basic language functions such as reading, writing, and speaking, memory, mnemonic functions such as *transforming* information into easier to remember forms (Morin, 2011), face learning, and planning (Lidstone, Meins, and Fernyhough, 2010).

Healthy IS use is particularly associated with positive psychological functioning. For example, one model emphasizes the role of IS in healthy functioning of the neurocognitive action self-monitoring system (NASS or multi-component system involved in self-regulation; Jones and Fernyhough, 2007). Researchers implicate IS deficits in psychological disorders such as anxiety, depression (Morin, 2005), schizophrenia (Jones and Fernyhough 2007), ASD (Shopen, 2014), and others (for more on SA deficits, see Part 2, section 2). Using positive self-talk as a tool to decrease and increase target behaviours has been shown to be an effective treatment for those with depression and anxiety (Loades, Clark, and Reynolds, 2014).

### **1.6.2. PS**

PS serves an early functional, “less mature” form of self-regulation (Furrow, 2014, p. 155.) Inner speech and PS both seem to share heavy involvement in executive functions. Diaz and Berk (2014) delineate the involvement of PS in self-regulation of basic perceptual, attentional, motor, and memory processes involved in voluntary attention, mnemonic strategies, planning, problem solving, and regulation of impulsivity. Private speech also assists in marking important conceptual transitions and endings, modulating affective states, self-praise and self-motivation in times of weakening persistence of performance on boring tasks, facilitates spatial orientation (Diaz and Berk, 2014), mediates emotional regulation and cognitive task performance (Day and Smith, 2013), and is a mode for self-information (Shopen, 2014). Similar functions are associated with IS use, as showed in 1.6.1.

## **2. PS and IS Deficits in ASD: Mixed Evidence**

Williams and colleagues (2012) give several empirically supported reasons why the behavioural and cognitive features in ASD are potentially related to specific IS impairment:

(1) those with ASD do not report intact IS (although we argue that the range of ASD IEs is not yet clear), (2) those with ASD tend to have impairments in self-regulation and executive functioning that are reminiscent of other low IS populations, (3) some studies show consistent difficulty for ASD individuals to perform well on tasks that require IS to maintain novel rules and arbitrary information. However, the following studies show support for intact IS in some sub-populations of ASD.

In support of intact PS and the strong role of PS in executive tasks in ASD, Winsler, Abar, Feder, Schunn, and Rubio (2007) found that the amount of PS used by high-functioning children with and without ASD during an executive set-shifting task and a planning task was comparable, that PS was task relevant, and that PS was positively related to better than worse task performance (although see Williams and Jarrold, 2013). Williams and Jarrold (2010) argued for intact IS use in children with ASD by considering differences in verbal mental ability (VMA) and cognitive profile (IQ). They found that VMA is varied regardless of where individuals are on the spectrum, be it Asperger's syndrome, high functioning-autism, mixed-ability children with autism, or low-functioning children with autism. In another study by the same authors, VMA significantly predicted IS use in short-term memory tasks, while cognitive profile was not a significant predictor of IS mediation short-term memory in ASD, suggesting that VMA plays a significant role in IS use on memory tasks in these individuals.

In typical samples the commonly used articulatory suppression task ties up verbal resources (IS) and decreases performance on executive functioning tasks (memory, planning), which suggests intact IS to be available and actively used in the first place before interruption. In the same way, being unable to recall phonologically similar stimuli well during tasks meant to tie up verbal resources is indicative of detectable IS use (phonological similarity effect or PSE), and being unable to recall visually similar stimuli during tasks meant to tie up visual resources is indicative of detectable visual mediation (visual similarity effect or VSE). In a sample of ASD and ability matched children above or below VMA of 7, participants were asked to complete a recall task using either phonologically similar features, visually similar features, or control items containing neither phonologically similar features or visually similar features. Those with VMA above 7 years had worse performance recalling phonologically similar stimuli than recalling control stimuli (suggesting IS use increases with VMA regardless of ASD or control), but those with VMA below 7 recalled visuo-spatially similar stimuli less well than control stimuli (suggesting visual mediation instead of IS use before VMA of 7 regardless of ASD or control; Williams, Happe, and Jarrold 2008).

Researchers note that children who had a VMA below 7 years showed a large visual similarity effect (VSE) but no phonological similarity effect (PSE) during short-term (ST) memory tasks, and data from children with a VMA above age 7 showed a large PSE but not a large VSE during ST tasks. This suggests that children first visually mediate ST, then verbally mediate ST with IS (Williams, Bowler, and Jarrold 2012). In other words, typically prior to VMA of age 7, pictorial information is represented visually in ST memory and that after about VMA of age 7, pictorial information is recoded and stored using IS.

Williams and colleagues (2012) investigated the mediating role of IS in ST memory and planning in adults with ASD and typically developing matched adults to detect a possible shift in visual and verbal mediation depending on VMA. Participants with and without ASD used IS to facilitate ST memory, and again they argued for the recoding of visual stimuli into a phonological (IS) code, but this time in ASD adults. Performance on a planning task however, was significantly affected by articulatory suppression for the control group, but not

for the ASD group, leading the researchers to conclude that planning is not mediated by IS for those with ASD because of the absence of an effect on IS suppression. Therefore, perhaps IS mediates memory, but not planning in ASD. In sum, some children and adults with ASD show developmentally appropriate use of IS in the form of verbal mediation of ST memory, and we suggest other cognitive resources such as visual mediation may facilitate planning more in some with ASD than others who may use more IS to facilitate planning, with precise individual differences in IEs and cognitive abilities still needing research.

It is not clear whether or not VMA or IQ are significant predictors of IS use, or that IS plays a role in all executive functions in those with ASD. Therefore, Williams and Jarrold (2010) state that it would be premature to assume “blanket deficits” (p. 912) in those with ASD, arguing for the complexity of conditions under which IS may be employed, as well as the complexity of underlying factors in ASD. The authors suggest that some with ASD may therefore not have the capacity for IS, while others may not be able to utilize their capacity for IS, or may only use IS under specific conditions (e.g., to mediate memory but not to plan), while others still may have a completely intact capacity for IS in executive functioning. These suggestions make sense considering our review, which implicates multiple aspects of IS.

### **3. IS and ToM: A Complex Relationship**

#### ***3.1. Empirical Evidence***

Dimaggio et al., (2008) posited multiple paths of influence of SA on ToM), suggesting that based on empirical evidence, it makes sense that ToM may involve numerous related but distinct capacities that can be intact or impaired independently. At the same time, ToM may involve numerous distinct cognitive processes. These arguments are reminiscent of IS arguments about multiple possible processes and functions that have been suggested so far.

Fernyhough and Meins (2009) gave three empirically supported reasons why PS and ToM development may be linked in childhood and note how SA may be involved: (1) PS use in self-regulation requires an understanding of a self (SA) that can use language to represent itself (IS), so that those children who are advanced at internalization of PS (IS) show higher ToM abilities, (2) PS may contribute to SA about the self as distinct from others, (3) PS may become internalized as IS through social interaction (potentially involving ToM or inferences about correct internalizations through social reinforcement, e.g., “That smile... I’ll keep doing that...”). Therefore, PS and ToM may have some functions and processes in common which may actually facilitate each other back and forth in development.

Newton and de Villiers (2007) tested individuals’ ability to perform a false-belief task while speech processes were tied up. If speech is important for ToM, then disrupting the ability to access language resources (IS) should cause failure on the ToM task. In their results, verbal shadowing but not rhythmic shadowing disrupted false-belief reasoning (ToM). The false-belief reasoning abilities of two aphasic individuals who could not produce or demonstrate understanding of syntax apparently contradicts the above results; however, Newton and de Villiers (2007) argued that the contradiction could be explained by the limited use of language resources by executive functions that support false-belief reasoning tasks, and that these limited language resources may be easily blocked. For example, reasoning tasks could be completed without language resources, but that the outcome of reasoning, that is

decision-making information, must be held in the phonological loop, which is tied up during verbal suppression tasks. Based on scant evidence therefore, we must conclude that the relationship between IS and ToM remains unclear.

### ***3.2. Potential Moderating and Mediating Factors***

Moderating and mediating factors can also affect the relationship between variables such as IS and ToM. For example, language is postulated to play a large role in the development of social interaction and PS as argued earlier in the chapter. However, whether IS use is a direct function of PS, and whether it is *language* or *social interaction* that most significantly contributes to this relationship is still in need of further research. What constitutes genuine language is a question that Malle (2002) addressed, arguing that in defining language, the phonological levels of language should be unimportant because symbolic signing systems function without phonological components, but that other levels of language (morphology and syntax) vary extensively with some present in other symbolic signing systems.

Language development and activities thought to rely on ToM have a lot in common. For example, there is evidence that typical development, word learning and language use, pretend play, and joint attention all develop by about 18 months (Frith and Frith, 2003). Some researchers assert that language learning is facilitated by a capacity for learners to track intentions of speakers. Useful words are thought to be tracked because of their association with intentional benefits (e.g., recognizing that mother names objects for their usefulness rather than for no reason). Recognition of these intentions is thought to be evident based on the logic that without these associations, children would learn accidental sound and object associations, which is not the case. Whether learning words based on beneficial consequences is related to awareness of a speaker's intentions, is a consideration further addressed in Malle (2002).

Pretend play is thought to rely on aspects of ToM (i.e., the understanding of pretense), emerging around 18 months in typically developing children. Frith and Frith (2003) gives a commonly used example of other researchers' prior work meant to show this; when a mother holds up a banana as a pretend telephone, the child laughs and does not act confused, demonstrating the child's ability to separately represent the banana's real properties and the mother's intent to use the banana in an alternatively playful manner (i.e., the mother's attitude toward the banana is separate from the real use of the banana). The ability has been termed as "decoupling" (p. 48) whereby the need to represent real properties of objects (language) is kept separate from thoughts or attitudes about intent (ToM) in relation to real properties of objects. Whether or not the child in this example was aware of the mother's intent to play, or whether the child was modeling playful behaviour from the mother without mentalizing about the mother's intentions, remains to be seen. Either way, pretend play and rapid language acquisition both rely on the capacity for joint-attention, when defined by the strictest definition, requiring the attention of one to be drawn intentionally by the other.

What is clear is that social interaction, language, and ToM have something in common. Malle (2002) synthesized these factors into a multi-directional model, suggesting that levels of ToM-1 and ToM-2 may underlie development and evolution of social cognition in general. Physical navigation of self and others facilitates early ToM-1 (also see Part 2, section 3.4 for face and eye gaze as lower level ToM). Higher levels of social navigation require use of ToM-1, language, and mentalizing about the self and others, facilitating later ToM-2. Therefore, the direction of cause and effect of IS on ToM, as well as the nature of moderating

and mediating variables is still unclear, with mixed evidence and theoretical reasoning pointing toward co-development (and maybe co-evolution) of ToM and IS capacities.

#### **4. Are ToM Deficits in ASD Caused by IS Deficits?**

While it is clear that IS and ToM overlap in many areas, there is contentious debate about the causal direction of these relationships in both typical and atypical contexts. The same debate permeates directional claims involving all of language, social speech, social interaction, SA, IS, and ToM on each other. Specifically in regards to the development of IS and ToM, it could be that (1) PS and IS precedes ToM, (2) ToM precedes PS and IS, or (3) PS, IS, and ToM co-develop. We find that the available evidence is so varied that it is tempting to think the third of these suggestions may be the most plausible, although the complexities of these relationships need to be delineated before making any claims about the exact nature of this relationship. Furthermore, we suggest that claiming directions of cause and effect between IS deficits and ToM deficits is questionable given the unclear nature of the relationship between IS and ToM in the first place.

Internal State Language (ISL), or language used to describe internal thoughts and emotions, is used to look at the ability to access social information through interaction (Siller, Swanson, Serlin, and Teachworth, 2014). Based on the logic that language difficulties (e.g., formulating narratives) contributes to problems organizing personal experiences, the authors suggest that these problems are related to problems in social functioning due to the inability to use language resources to accurately organize self-related information and convey it to others. Therefore, it seems possible that problems with IS use (language; organizing self-related information) could lead to problems with ToM (telling narratives to others). However, if language is socially influenced, then it is possible that early forms of ToM developed alongside early social communication, potentially reinforcing later IS use. It could also be that language, IS, and ToM co-develop alongside each other, reinforcing each other, advancing through social interaction and the need to communicate. For a thorough outline of ToM and language co-development and co-evolution, see Malle, 2002.

Hurlburt and colleagues (1994) did not find support for IS use in their examination of IEs in 3 adults with asperger syndrome using DES, but using typical ToM tasks, they did find evidence of intact ToM abilities in each sample, with level of ToM ability positively correlated with ability to report on IEs. Therefore, based on very little evidence, it is possible that intact IS may not be needed for intact ToM.

Newton and deVilliers (2007) provide three views of language involvement in thought, and we relate how these can involve elements of ToM: (1) Language may accessed whenever there are chains of inference (such as inferring false belief in ToM), (2) Language could serve as a cross-modular bridge when information from more than one cognitive module is combined (ToM is potentially similar), and (3) Language may be used to represent truth and falsity (such as in false belief in ToM). This tight relationship between language, IS, and ToM still does not address the direction of cause and effect, but it suggests that language is fundamental to both IS and ToM. For example, IS and ToM may involve numerous related but distinct capacities that can be intact or impaired independently.

#### ***4.1. Role of Positive IS in Improving Self and Social Functioning in ASD***

There is evidence to support the role of positive self-talk (defined here as reinforcing self-statements aimed toward wanted behaviours) in improved SA and social functioning (Loades, Clark, and Reynolds, 2014), as well as increased ToM. Students with ASD report that they would like more satisfying social peer interactions, but that they do not know how to do so (Bauminger, Shulman, and Agam, 2003). One avenue of investigating IS use in ASD and how it relates to ToM is to look at what interventions seem to improve social skills and how IS plays a role. The most recent interventions include theatre (Social Emotional NeuroScience Endocrinology or SENSE Theatre; social interaction via teaching the acting role; Corbett et al., 2011), CBT centered games (multi-person multi-touch visual tabletops), video modeling (Apple, Billingsley, and Schwartz 2005), and social skills programming (encouraging strategies toward reflection and SA; Bellini and Turnbull, 2006).

White, Keonig, and Scahill (2007) reviewed the literature on effectiveness of Social Skills Training Programs (SSTP) in children and adolescents with ASD and found two studies incorporating ToM tasks in SST programs reporting significant improvements in ToM. However, results of improved ToM in one study did not correlate with low scores on a social skills measure in the same sample. The other study used measures of facial expression recognition and problem solving but not measures of day to day social functioning. Skills in other areas (functional behaviour, positive peer social experience, self and social skills and knowledge) marginally improved overall. The authors did suggest that specific promising strategies be taken into account and suggested (among largely rule based CBT strategies) increasing social motivation by fostering SA and self-esteem, both of which IS may play a role in. Rao, Beidel, and Murray (2008) also reviewed SSTPs for children with ASD, finding one SSTP that emphasized recognition and expression of emotions (through modeling and reinforcement), though it was unclear whether participants were reinforced for recognizing their own emotions. Southall and Gast (2011) compared self-management procedures for systematically altering one's own behaviour in 24 empirical studies of ASD, finding that, regardless of individual differences in ASD, self-management was effective for teaching both social and self-related (vocational, communication) skills and decreasing problematic (restrictive, repetitive) behaviour. Systematic self-management procedures include combinations of self-observation, self-recording, self-evaluation, self-reinforcement, self-punishment, and self-questioning have all (except self-recording) been shown to potentially involve IS (Morin, 2005).

While PS or IS use is not explicitly common among these interventions, and some have looked at reduction in self-talk as positive improvements toward social functioning, it is possible that participants rather use self-talk to facilitate the learning of social strategies (games, roles, self-esteem building, SA building, self-management). Positive self-talk as a cognitive method for replacing negative self-talk or rumination is an effective intervention in depressed, anxious, and schizophrenic samples (Loades, Clark, and Reynolds, 2014).

#### ***4.3. Anecdotal Observations of Positive Self-Talk in ASD***

Part 2, section 2.4 we touched on observations of ASD individuals using SA to regulate behaviours. Since there are good reasons to believe that positive self-talk may improve SA and ToM, we offer some anecdotal observations of positive self-talk in those with ASD. We clearly acknowledge limitations of inference in informal observation. Through multiple informal naturalistic observations of adolescents and adults with ASD (short term vocational



observation and training settings and a long term observation and treatment setting of 2 years), we observed clients engaging in PS made up of content that co-occurs with related activities, leading us to believe that functions of PS may include self-motivation to complete tasks successfully, to navigate the environment, to ask themselves questions and formulate answers, to remind themselves, to plan, to remember, to problem-solve, and to self-regulate during times of frustration (sometimes in creative manners such as acting, writing lyrics, or recording self in videos and audio recordings). PS has been observed to be used often, both in isolation (but heard by nearby staff) or in the presence of others (roommates, during social conversation). Clients in long-term observational and treatment settings (2 years) also consistently self-report use of positive self-talk to understand and to deal with difficult situations, using this cognitive thought-replacement tool (first facilitated by staff and counselors) as a positive procedure to replace negative self-talk. This is often practiced in conjunction with other positive techniques such as facilitating healthy SA through client/staff conversations, when clients both talk to staff and themselves within the same conversation; clients often differentiate PS from dialogic conversation with staff by pointing out “I was talking to myself” or “I was using self-talk” when staff respond to apparent PS, mistaking PS for dialogic conversation with staff.

Self-talk is often used to access information about the self (SA), for example, “Am I really like that...?” Negative self-talk in the form of rumination has led to built up frustration and then loss of behavioural control, so that those with ASD may especially prone to self-regulation failure. This makes sense considering the important role of IS in self-regulation (Tullett and Inzlich, 2010), and the loss of control that is commonly reported during behavioural melt-downs in ASD. This makes even more sense when we think about the main comorbid diagnoses in ASD, such as OCD and anxiety, disorders that involve issues around control.

The content of self-talk in ASD is also rich with questions about others (ToM), such as, “Do they think I’m mean?” or “She’s probably just got her own issues”. In the vocational or SSTP setting, those with ASD verbalize things such as “Will my boss think I’m a good employee?” or, “My parents will be very proud of me”. While these are informal observations, and procedures increasing healthy self-talk and SA are used in conjunction in these examples, clients in long-term settings have shown reduced frequency of frustration, increased frequency of tool use, reduced frequency of incident (threats, harm, or damage to property, self or others), and increased interest in quality of life, social interactions, and goals (self and community oriented). These very preliminary observations also have implications for improving SA and ToM in those with ASD. to illustrate, researchers could investigate the effectiveness of positive self-talk compared to neutral self talk in different settings (vocational skills training, SSTPs, clinical settings) among different populations (verbal or non-verbal).

## **5. Methodological Considerations**

### ***5.1. PS and IS Measurement***

Diaz (2014) wrote that current category systems of PS confuse content (i.e., what; referential and semantic aspects of language), function (i.e., possible effects of utterance on behaviour), and form (i.e., prosodic and structural aspects such as loudness, intonation, syntax, deletions, durations, and fragmentations). Furthermore, researchers often categorize

PS functions by inferring the functions from the content of the PS. In the same vein, the categorization of any phenomena needs to be justified by useful, feasible, explicit, and observable differences. Similarly, it is important to understand the difference between the contents, functions, and processes of IS. For example, the *process* of introspection (how one thinks about the self) could be distinct from the *product* of introspection (the thought or speech), rendering possible discrepancies between verbal reports and actual IS (and IEs in general; De Guerrero, 2005). Drawing from these two methodologies, we suggest that perhaps IS researchers could use instances of explicit references to functions in participants' content samples while investigating correlations with behaviours (e.g., activities) in their coding schemes when researching functions versus contents of IS.

### **5.2. Self-Reports**

Hurlburt et al. (2006, 2011, 2013) critique the use of questionnaires in assessing IS, outlining five main observations: (1) issues with scale anchors, (2) items do not distinguish between IS and other IEs, (3) lack of consistent understanding and use of vocabulary, (4) lack of understanding or recognition of their own IEs, and (5) limited measurement of IS characteristics due to pre-existing assumptions about IS functions. However, Hurlburt and colleagues note that it may be quite difficult to develop simultaneously high fidelity phenomenology and high validity in questionnaires because each methodology has its utility and degree of ambiguity. Indeed, Uttl, Morin, and Hamper (2011) studied the reliability and validity of IS questionnaires (see table 5), and found that a majority are reliable but not valid, that is, they do not correlate. Therefore, many IS questionnaires are methodologically flawed or tapping into multiple aspects of IS, or both.

### **5.3. Retrospective Reports and Pristine Inner Experience in DES**

It may be impossible to directly access IS, but it may be possible to access reconstructions of the phenomenon. Hurlburt and colleagues cite John Mill, arguing that facts about events can be studied immediately after the event has past (seemingly during the experience), while impression in the memory is still very new. Further, agreeing with William James, they explain that when asked to recall an experience, one is performing analysis that is inherently self-biased due to both the process of apprehending the experience and the self-observational nature of the task. Hurlburt and colleagues therefore seek to investigate “pristine” inner experience, or the experience “as it naturally occurs before a specific attempt to alter it” (i.e., Hurlburt et al., 2013, p. 4; for immediate high-fidelity sampling, see 1.5.2).

These pristine apprehensions of inner experience may be different than actual inner experiences. However, immediate use of memory allows one to access new impressions of events, which, despite being reconstructed, are arguably our best chance of accessing representative samples of actual inner experiences (though see Engelbert and Carruthers 2011 for reliability, ecological validity, limitations, and suggested advancements to DES).

### **5.4. fMRI**

Brain imaging studies using fMRI of IS activation are useful for comparing areas involved in processing during tasks, but activation of areas could be affected by the use of pre-determined IS rather than self-generated IS during tasks. For example, Hurlburt et al. (2013) are in agreement with those who critically underline fMRI methods where participants

were asked to enter an fMRI magnet, listen to pre-recorded sentences, use IS to recite the sentences, then press a button indicating completion of the task. Whether participants actually engaged in the task, or whether reciting pre-determined sentences are representative of genuine IS, remains questionable. Research suggestions here include investigating the neuroanatomy (1) of IS in those with ASD using fMRI—does it differ from that of typical participants?, and (2) of different types of IS, for instance self-generated versus recited, or monologic versus dialogic forms of IS, as examined by Kühn et al., (2014).

## **6. Theoretical Considerations: A Preliminary Model of IS Development and Functions in the Context of ToM**

Our view of IS functions is shaped by the complex relationship between our physical and social environments, our need to navigate these environments, and our need to detect and process information about complex individual differences to facilitate navigation of these same environments. For example, IS probably facilitates awareness and understanding of consciousness in terms of relationships between the self and others by verbally communicating (IS) self (SA) and other (ToM) related information to the self so that information can be organized and further processed to assist in self-regulation (PS, IS) and interactions with others (ToM).

Information about the self and others is important for detecting individual differences in mentalizing used to predict outcomes of social situations (Frith and Frith, 2003), which is important for survival purposes if one considers the social nature of our species (e.g., reproduction, family, workplace, teams, politics). By this logic, functions of IS are multifaceted, and probably have multiple paths of influence. Elaborating on earlier arguments, we think it is almost impossible to claim direction of influence on these factors, but it seems most likely that social interaction, language, and SA co-develop with IS and ToM, with IS being a key factor facilitating back and forth influence on development.

## **7. Summary**

PS and IS studies have been useful in understanding the importance of content, frequency, and functions of self-directed speech in different samples. This knowledge motivates us to consider self-talk, as compared to other IEs and capacities such as ToM, as representing the most central process in human social cognition. This is because (1) self-talk constitutes a multi-process, multi-capacity information store and processing mechanism, requiring (2) multiple tools of measurement to capture and validate it, (3) having characteristics that fit with modularity theories, (4) involved in other potentially modulated areas such as SA, ToM, executive functioning, and ASD. Inner speech and language arguably co-evolve together as a function of the need to navigate the social environment, make successful attributions and inferences, and to distinguish between individual differences in mentalizing. The complex nature of social interaction in development is probably both a driving force and a byproduct of IS and ToM development (and evolution). Current methods attempt to distinguish IS from other IEs and other domains such as ToM without considering their possible overlap. This could be one reason why current IS findings are so muddy. This

especially makes sense if one considers the overall functions of IEs as potentially serving each other as a set of problem solving and mentalizing tools used across a connected modular network in the brain. Based on findings of positive functioning when using positive self-talk, another research suggestion is that PS in ASD can be recorded in clinical settings by staff who act as naturalistic observers of PS. Sometimes audio recording exists in housing facilities and can be accessed by staff researchers, which would facilitate this method. Further, naturalistic observation can be used to cross-validate IS measures for use in ASD populations, and to cross-validate ASD IS reports with fMRI technology. Gaining insight into IEs as experienced by those with ASD is important for understanding the big picture of overall human mentalizing. Specifically because of the hypothesized role of IS in ToM mentalizing, there is a great need for the further development, validation, and implementation of useful IS measurement tools for use in typical and ASD populations.

## CONCLUSION

In our view there is no doubt that SA, ToM, and IS constitute key processes involved in the most advanced forms of social cognition in human animals—that is, thinking about ourselves and others using sophisticated mental representations conveyed by language. We acknowledge the ambitiousness of our review and note that it is selective due to the massive available research. Our review of the literature on SA, ToM, and IS in typical and ASD individuals motivates us to formulate some important observations and recommendations. First, it is imperative not to equate seemingly related concepts because doing so paints an oversimplistic picture of an otherwise very complex reality. Oversimplification leads to biases and fallacies about mentalizing capacities, the processes involved, and the populations under study. For example, one would be mistaken to suggest that since self-recognition and SA represent very closely related processes, and since self-recognition is located in the right hemisphere (which it actually is not, as seen in Part 1, 3.4.1) then SA is too. A variation on this theme could be: SA most probably leads to ToM (the Simulation theory); consequently, SA deficits observed in ASD are bound to lead to ToM impairment. As seen in Part 2, there is no evidence supporting such a clear-cut prediction.

Second, those with ASD have robust differences in individual factors (e.g., comorbidity, verbal mental ability). This makes it very problematic when comparing their social and cognitive functioning to that of typical individuals—themselves exhibiting remarkably complex individual differences. Indeed, very few studies have examined individual differences, used control groups, or used sufficient sample sizes. Third, it should also be rather obvious by now that SA, IS, and ToM do not represent uniform constructs either present or absent in typical and ASD folks. The highly mixed empirical evidence alone stands to highlight the possibility that these constructs may not rely on each other in only a singular direction, and that deficits in these constructs may occur independently of each other. Further, considering the potential modularity involved in both typical and ASD brain connectivity and function, and the potential modularity of IS, SA, and ToM in the brain, it becomes even more evident that deficits are causally related in very complex ways. Moreover, deficits and development are probably both impacted in a back and forth way, which could also be explained by modularity theories.

Fourth, any theoretical proposal suggesting that IS leads to SA, or that SA leads to ToM, or that IS leads to ToM, and vice versa, is bound to be too simplistic. The study of these intricate relationships can be further advanced by methodologies that take moderating and mediating factors (e.g., social interaction, language) into account, utilize wider social contexts (e.g., PS in social interactions), and refrain from simplistic categorizations and assumptions (e.g., PS contents equal PS functions). Even the most seemingly straightforward study of what was thought of as a singular component of cognition, IS, becomes a study of complex relationships after the acknowledgement of potential service to many other functions, processes, and anatomical correlates. To advance research, we suggest comparing fMRI scans of IEs to see how they overlap and differ during various self generated (sporadic) and/or predetermined instances. ToM, IS and SA activations during thought tasks could be compared and controls could be researchers trained to understand the differences between IEs. Participants could be trained or non-trained in that respect before engaging in fMRI thought tasks, and could be from verbal or non-verbal populations, including those with ASD.

In sum, the discrepancy between observations of intact SA, IS, and ToM in clinical settings and empirical reports of deficits in these areas of functioning in ASD could be due to many factors: (1) ASD is a new diagnosis with many complex neurobiological and developmental underpinnings, (2) although ASD populations have been observed in their naturalistic environment, their actual inner experiences have rarely been systematically studied, (3) Functions assumed from studying the contents of self-talk need to be established with more evidence, (4) Measures of SA, IS, and ToM reveal inconsistent results and validity, and (5) inconclusive results regarding the direction of cause and effect relationships between all these factors in typical and atypical contexts warrants investigation of a more multi-directional path of influence.

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