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## **I Remember Me**

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## ABSTRACT

It is well established that children recognize themselves in mirrors by the end of infancy, showing awareness of the self as an object in the environment. However, the cognitive impact of objective self-awareness requires further elucidation. This gap in the literature is addressed in a series of 7 experiments exploring the role of self in 3- and 4-year-olds' event memory. A mnemonic bias for self-relevant material has been described in adults. This effect is thought to be based on the organizational properties of a highly elaborated self-concept and so offers a clear route to study the child's developing sense of self. However, very few studies have investigated the ontogeny of this effect. New evidence is provided to suggest that preschool children, like adults, show a mnemonic advantage for material that has been physically linked with the self through performance of a depicted action (Experiment 1). Moreover, 3- and 4-year-olds show a bias for material that has been visually and linguistically processed with the self-image (Experiments 2, 3, and 4) and material that has been socio-cognitively linked to the self in terms of ownership (Experiments 5, 6, and 7). The data imply that both bottom-up (kinesthetic feedback and self-concept) and top-down (attention) aspects of self-reflection may play a supporting role in early event memory, perhaps representing a nascent form of autobiographical processing. Importantly, this research highlights a promising methodology for elucidating the executive role of the self in cognition. Following William James's (1890) influential conception of the self, it seems that in typical development, "I" is primed to remember "me."

## I. WHY INVESTIGATE MNEMONIC SELF-REFERENCE EFFECTS IN PRESCHOOLERS?

Self-recognition is a key milestone of human development in both ontogeny and phylogeny. Possibly unique to the great apes among nonhuman primates (Gallup, Anderson, & Shillito, 2002), the ability to self-recognize typically emerges in humans at around the age of 2 years. A litmus test of this development is the mirror mark test of self-recognition (independently developed by Gallup, 1970, for nonhuman primates, and Amsterdam, 1972, for human infants). In this test, infants are surreptitiously marked (classically with rouge) in a visually inaccessible area (such as the forehead). To pass, they must take appropriate self-directed action when a mirror is introduced, reaching for or trying to remove the mark. This simple behavior indicates that the participant has inferred a relationship between the mirror image and themselves. In other words, they have cognitively identified themselves as an object in the environment.

The development of the capacity for self-recognition might be considered fundamental to human social cognition and interaction. Without it there would be no concept of “me” as distinct from “you,” no self-conscious thought or emotion, no theory of mind, and no moral connection between us. Arguably, few other developmental events have such weighty consequences. Yet it is only in the past 40 years that measures of the onset of self-recognition have been elaborated. Moreover, the first objective test of early self-recognition, the 1970s mirror mark test (Amsterdam, 1972; Gallup, 1970), is still the most commonly used. In humans, where eventual self-recognition is an established norm, the mirror test is typically employed with the aim of correlating the results with other cognitive, linguistic, or emotional measures. This approach has produced a large body of interesting research (reviewed later), firmly establishing the “mirror mark test” of self-recognition as a measure indicative of a wider sense of self-awareness. However, the development of other empirical tests of early self-recognition has stalled.

This is regrettable because the dependent variable of the mark test, mirror guided reaching for a mark on the face, offers only a limited expression of self-recognition. Although physical self-monitoring conceivably has some evolutionary value, the primary consequence of self-recognition is not

grooming.<sup>1</sup> Rather, as outlined earlier, self-recognition spurs the complete transformation of one's cognitive and social landscape. Empirical tests that incorporate this deeper level of self-recognition may therefore shed more light on the role of self-reflection in human development. The research described in this monograph pioneers such tests. Specifically, the studies reported here were designed to explore the role of self-recognition in event memory—a fundamental aspect of human cognition—in early life. The methods used are adapted from an established body of research that describes a mnemonic bias in adults for material processed as self-relevant. This bias, thought to be based on the elaborative or organizational properties of the self-concept, is known as the self-reference effect (SRE). Although offering a potentially simple route to observe an important functional aspect of self-recognition, only a handful of studies ( $N = 6$ ) have investigated this effect in childhood. Moreover, despite the early onset of self-recognition, only one of these studies looked for the effect in children younger than 5 years of age.

An advantage of using the SRE paradigm to study the emergence of self is that it allows investigation of the self as a “whole.” Most simplistically described as the belief “I am me, I was me, I will be me,” the human experience of personal identity is a universally experienced, yet under-researched, phenomenon. In making the claim “I am me, I was me, I will be me,” we refer to distinct aspects of the self. A distinction can be made not only between the self in the past, present, and future but also between the agentive “I” and the descriptive “me.” Indeed, William James (1890) was the first to make this distinction, breaking self-knowledge into various categories (material, social, spiritual) and referring to the “I” self as the keeper of this knowledge, greater than the sum of its parts. Modern researchers have followed suit, seeking to understand self-awareness by categorizing various aspects of the self (e.g., see Duval & Wicklund, 1972; Lewis, 1991; Neisser, 1988). However, the sum of these parts (the “I”) has largely been left to philosophical enquiry. Moreover, in modern research, the Jamesian “I” is often equated with the self-perceived subjectively (e.g., kinesthetic feedback), contrasting this to objective self-knowledge. However, agency is experienced both subjectively and objectively. It requires explicit self-reflection to abstract from the sum of parts the claim for “I” (a unified personal identity). Likewise, subjective experience arises from many aspects of objective knowledge (consider the knowledge “I am charitable”).

Perhaps understandably, psychologists have tended to avoid this overlap, studying the self in strict dichotomy. However, over a century since James's (1890) dissection of the self, attempts to put the self back together again are arguably long overdue. This is regrettable because James (1890), and subsequently Mead (1934), offered a relatively simple empirical route to the study of the elusive “I.” They suggested that agentive experience of the self might be measured by focusing on the consequences, as opposed to the

content, of self-recognition. The idea here is that in observing the cognitive or behavioral impact of self-recognition, we infer the existence of a self-reflective agent. The SRE paradigm, measuring the impact of self-recognition on memory, represents such a method. Moreover, it is well suited to capture the interplay between subjective and objective factors that constitute real-life experience of self-awareness. By applying this method in early childhood, we might achieve a fuller picture of the onset of self-awareness than one based on the mirror mark test (though see a later discussion of the twin contribution of “I” and “me” to mirror self-recognition).

Finally, the SRE paradigm also has the potential to provide an alternative route to the study of autobiographical memory, the onset and foundation of which has been the subject of much controversy (see Howe, Courage, & Edison, 2003, for a review of competing theories). For adults and children, autobiographical memory has typically been measured by eliciting event narratives. Previous research suggests that preschool children can report detailed memories for life events after sizable delays. For example, Fivush, Hudson, and Nelson (1984) reported that preschool children were able to recall and identify pictures of a museum and its layout up to 1 year after they had visited it with their play group. Similarly, Hammond and Fivush (1991) found that 2.5- to 4-year-old children could accurately answer questions about a trip to Disneyland after an 18-month delay. These studies show that, when prompted, preschool children can report explicit memories of past events. However, autobiographical memories cannot be reduced to external expression. To access and maintain information concerning one’s involvement in a past event requires an internal, autobiographically organized system. It is arguably this system, as opposed to its linguistically and socially challenging product (a narrative), which is at the root of personal identity. Following this reasoning, the studies described in this monograph aim not to elicit early autobiographical event narratives but to experimentally assess the extent to which the self has an active role in preschoolers’ event memory.

The SRE paradigm has the potential to provide theoretically rich and ecologically valid data concerning the cognitive, and in particular the mnemonic, impact of self-recognition in early life. In the remainder of this chapter, previous research concerning the onset of self-recognition and its cognitive and social correlates is reviewed, paying particular attention to what the mirror mark test of self-recognition implies for a wider sense of self-awareness. There then follows a review of evidence linking the development of self-recognition and memory, including the small number of studies applying the SRE paradigm in childhood. Finally, the key research questions that are addressed by our own studies are described. The primary aim of this chapter is to set the current research in historical and theoretical context, providing an integrative basis for later interpretation of our results.

## THE DEVELOPMENT OF SELF-RECOGNITION

Supporting a precocious capacity for self-recognition, newborn infants discriminate their own cries from those of others, failing to show contagion of distress when exposed to their own, rather than another infant's prerecorded cry (Dondi, Simion, & Caltran, 1999; Martin & Clark, 1982). Moreover, by 3 months of age, infants appear to discriminate their own image from the images of others. Field (1979) demonstrated that 3-month-olds show decreased social and cardiac responses to their own mirror image versus the visual stimulus of a peer. Further, Bahrack and Watson (1985) and Legerstee, Anderson, and Shaffer (1998) showed that 3- and 5-month-old infants appear already familiar with their own image, preferring to view a live video image of an unfamiliar peer. Legerstee et al. (1998) and Rochat and Striano (2002) reported that, at least by 4 months, infants make significantly more social responses (vocalizing and smiling) to live representations of other people, even when contingency is controlled for through mimicry.

However, children do not behave as though they have a cognitive understanding that they are the object reflected in the mirror (an idea of "me") until the end of infancy. As noted, this aspect of self-awareness is measured by the mirror mark test of self-recognition (Amsterdam, 1972; Gallup, 1970). The finding that children below the age of 18 months typically fail the mark test of mirror self-recognition is robust (see Anderson, 1984, for an early review; later papers include Asendorf & Baudonniere, 1993; Asendorf, Warkentin, & Baudonniere, 1996; Bard, Todd, Bernier, Love, & Leavens, 2006; Courage, Edison, & Howe, 2004; Howe et al., 2003; Lewis & Ramsay, 2004; Nielsen & Dissanayake, 2004; Nielsen, Dissanayake, & Kashima, 2003; Nielsen, Suddendorf, & Slaughter, 2006; Vyt, 2001).

Importantly, younger infants do not fail the mark test due to an inability to follow task requirements. Prompts drawing attention to the marked area, or asking children to wipe the mark with a tissue, do not alter behavior (Courage et al., 2004; Howe et al., 2003). Likewise, younger infants perform well when asked to respond to directly visible marks on their mother's face (Lewis & Brooks-Gunn, 1979), a doll's face (Asendorf et al., 1996; Bard et al., 2006), or their own hand (Nielsen et al., 2003). Comparing infants with and without prior exposure to mirrors, Priel and de Schonen (1986) showed that although locating other objects using the mirror was related to previous experience of reflective surfaces, self-directed behavior was not. In doing so, Priel and de Schonen (1986) supported the cross-cultural validity of the test. Although there appear to be cultural variations in the onset of mirror self-recognition within the 18- to 24-month window, later work has supported the conclusion that mirror self-recognition is universal (Keller et al., 2004). Note, although this result provides welcome validation of the mark test, it also confirms that the developmental period during which the mark test

can be used to differentiate children in terms of self-awareness is extremely limited.

Priel and de Schonon's (1986) results imply that prior experience of mirrors is not necessary for contingency detection in a mirror image. However, in populations where mirrors are common, it is not clear if contingency awareness precedes mirror self-recognition. Lewis and Brooks-Gunn (1979) reported that 8-month-olds looked longer at a live image of themselves than a delayed self-image, or a prerecorded image of another child. Likewise, Field (1979) reported that, although reacting more positively to an image of a peer, 3-month-old infants looked longer at their mirror image. However, as noted, several other reports indicate that infants prefer images of others to contingent images of themselves (Bahrick & Watson, 1985; Legerstee et al., 1998; Rochat & Striano, 2002). Although the direction of bias differs, these studies imply that very young infants distinguish displays on the basis of contingency. In other words, they appear to have a sense of agency ("I") that facilitates implicit self-recognition. In support of a link between agency and preference, Morgan and Rochat (1995) found that although infants preferred viewing another infant's kicking legs to their own when no goal was involved, this pattern was reversed when kicking the object activated a sound.

However, in a more recent longitudinal sample of 9- to 24-month-old infants, Nielsen et al. (2003) failed to find a significant preference in either direction prior to 18 months. Tracking preferences individually, infants began to prefer their own image to that of a peer only in the session where they first demonstrated mirror self-recognition as measured by the mark test. This result implies that implicit self-recognition (as measured by preference) and explicit self-recognition (as measured by the mark test) may not be developmentally dissociable. Preference is notoriously difficult to interpret, and a potentially less ambiguous measure of contingency detection is provided by object search studies. However, the results remain equivocal. Bertenthal and Fischer (1978) and Bigelow (1981) reported that prior to mirror self-recognition, infants are able to use the mirror to guide their search for objects: for example, reaching up to a hat held above their head or turning around to fetch a toy. However, more recently, Vyt (2001) and Courage et al. (2004) showed that the ability to use reflective surfaces to infer the location of objects is variable in onset, sometimes preceding and sometimes following mirror self-recognition.

Perhaps the clearest evidence for the role of contingency in mirror self-recognition is the finding that identification of self in the mirror typically precedes identification of the self in static photographs by a few months (Brooks-Gunn & Lewis, 1984; Courage et al., 2004; Johnson, 1982; Lewis & Brooks-Gunn, 1979). This simple test strongly suggests that cognitive representation of one's own features ("me") can, at least briefly, be dissociated from cognitive identification arising from proprioceptive or kinesthetic feedback (a sense of "I"). However, experimentally manipulating contingency does not

always produce such straightforward results. In an innovative adaptation of the mark test, Povinelli, Landau, and Perilloux (1996) showed children videos depicting a marking event that had taken place 3 min earlier. Despite labeling these images as self-referent, the majority of 2-year-olds failed to reach for the mark until a contingency-providing stimulus (the mirror) was introduced. Further, it was not until the age of 4 years that the majority of children exhibited mark-directed behavior. Given that both 2- and 3-year-olds were able to label their video image (implying self-recognition), Povinelli et al. (1996) interpreted this result as suggesting that younger children cannot objectively connect the experience of past and present selves. That is, although they can use contingency cues and feature matching to recognize themselves in the present, they have no explicit representation of the self in the past.

In support of a specific deficit in *self-conservation*,<sup>2</sup> 2- and 3-year-olds appear to be aware that videos can reflect nonself-referent aspects of the past; they can learn to use videos of hiding events to guide their search for objects (Skouteris, Boscaglia, & Searl, 2009; Skouteris & Robson, 2006; Skouteris, Spataro, & Lazaridis, 2006; Suddendorf, 2003; Troseth, 2003). However, implying that any developmental lag in self-conservation is not as wide as originally proposed, this training facilitates 3-year-olds' (but not 2-year-olds') mark-directed behavior (Skouteris et al., 2009; Skouteris et al., 2006; Skouteris & Robson, 2006). Of further detriment to Povinelli et al.'s (1996) account, there is evidence to suggest that younger children mistrust video self-representations even when they are live. Although it is widely assumed that live video footage is an adequate mirror substitute, Povinelli, Landau, and Perilloux (1996; Experiment 3) found that only 60% of 3-year-olds passed the mark test in this medium.

In response to this, and similar findings (Johnson, 1982; Vyt, 2001), Suddendorf, Simcock, and Nielsen (2006) directly compared mirror self-recognition and live video self-recognition in a sample of 2- to 3-year-olds. Strikingly, although 90% of 2-year-olds passed the mirror test, only 35% passed a mark test using a live video. Tallying with the revised pass mark for the delayed test, success in the live video test did not match that of the mirror mark test until the age of 3 years. This result was replicated by Skouteris et al. (2009). Although Demir and Skouteris (2008) demonstrated that 2- and 2.5-year-olds' ability to pass the live mark test could be improved by training, performance was not brought to ceiling. This result suggests that video-based tasks put younger children at a disadvantage even when contingency is held constant.

Circumventing such concerns, an alternative task for self-awareness in which self-reflection is fully internalized has recently been revived. Inspired by the observations of Piaget (1953/1977), Geppert and Kuster (1983) and Bullock and Lutkenhaus (1990) tested whether young children sitting on a mat appreciated that their body weight was an obstacle when attempting to



hand the mat to the experimenter. They found that passing this task ontogenetically preceded mirror self-recognition (Bullock & Lutkenhaus, 1990; Gepper & Kuster, 1983). More recently, Moore, Mealiea, Garon, and Povinelli (2007) developed a new apparatus, designed to provide a less familiar (and so less easily solved) problem. In this task, children are placed on a rug that is attached to the axle of a shopping trolley and are encouraged to push the trolley toward their mother. For the trolley to move, children first have to step off of the rug. To 15-month-olds' evident frustration, the need to remove one's body weight is not appreciated until 18–21 months of age. As might be expected, Moore et al. (2007) found that passing this task strongly correlated with mirror self-recognition. However, unlike mirror self-recognition, which at least in later stages involves feature matching, this task does not require accurate knowledge of the body. Most 18- to 26-month-olds make body representation errors, such as attempting to put on dolls' clothes, sit on dolls' chairs, or squeeze through spaces that are too small (Brownell, Zerwas, & Ramani, 2007; De Loache, Uttal, & Rosengran, 2004).

Despite recent controversy concerning self-conservation, it is commonly accepted that mirror self-recognition is indicative not only of embodied or featural self-awareness, but a wider sense of self-reflection. This conviction is supported by concurrent developments in linguistic and affective domains. For example, from around 18 months of age, children begin to refer to themselves using their own name, and as early as 20 months they show systematically correct usage of first- (“I, me, my, mine”) and second-person (“you, yours”) pronouns (Bates, 1990; Brown, 1973; Hay, 2006). Supporting the view that linguistic self-reference is premised on objective self-recognition, children who pass the mirror mark test show more linguistic self-other differentiation than non-self-recognizers (Courage et al., 2004; Lewis & Ramsay, 2004). Moreover, children's verbal labeling of the mirror image typically lags slightly behind nonverbal behavioral indicators (Amsterdam, 1972; Bard et al., 2006; Bertenthal & Fischer, 1978; Pipp, Fischer, & Jennings, 1987).

Acting on Amsterdam's (1972) observation of self-admiring and coy mirror behavior in 21- to 24-month-olds, Lewis, Sullivan, Stanger, and Weiss (1989) confirmed that embarrassment (expressed through averted gaze with smile, blushing, facial touching) typically occurred in self-recognizers but not non-self-recognizers, both in the mirror- and in public-exposure situations (e.g., being asked by the experimenter to sing). Children's empathic reactions to others' distress (as measured by sad facial expressions, prosocial helping, sharing, and comforting) have also been repeatedly linked to the onset of mirror self-recognition (Bischof-Kohler, 1991; Johnson, 1982; Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992). These results are notable because to feel embarrassment or empathy one must consider oneself as other, that is, pass an emotional analog of the mirror test. However, cognitive and emotional consideration of self and other are not complete at

age of 2 years. Self-conscious emotions involving evaluation of self against a standard (as in, e.g., pride or shame) are not established until at least 3 years of age.

For example, Heckhausen (1984 and later Stipek, Recchia, & McClintic, 1992) found that following success in a competitive task, 3- and 4-year-olds (but not 2-year-olds) looked toward their competitor, stretched their body and arms upwards, and displayed positive affect. Following failure, the children no longer made eye contact, their body shrunk downwards, and they displayed negative affect. These reactions are consistent with the prototypical expressions of pride and shame. Further, Lewis, Alessandri, and Sullivan (1992) demonstrated that by the age of 3 years, children show more pride when succeeding on difficult than easy tasks, and the converse for failing and shame. This confirms that children's reactions are not simply based on positive and negative outcomes. More recently, Kochanska, Gross, Lin, and Nichols (2002) reported that the level of self-recognition reflected in language and behavior at 18 months correlated with "guilty" behavior (averted gaze, body tension, distress) following a staged mishap in the laboratory at 22 and 33 months. Mothers' reports of naturally occurring guilty reactions (averted gaze, body tension, distress, seeking reparation) increased during this period.

Bringing all of these facets of self-awareness together, Stipek, Gralinski, and Kopp (1990) pioneered a parental questionnaire of infants' self-concept development with three factors. Factor 1 referred to self-description and evaluation (e.g., Does your child ever use evaluative language to refer to themselves?). Factor 2 referred to bodily self-recognition (e.g., Does your child recognize herself in mirrors?). Factor 3 related to emotional responses to wrongdoing (e.g., Does your child ever seem upset when calling attention to something he/she has done wrong?). Collecting data for a sample of 19- to 40-month-olds, Stipek et al. (1990) found the expected developmental progression at 19–24 months, 91% of children scored highly on self-recognition, compared to 51% on self-description and evaluation (rising to 91% between 30 and 40 months), and 40% on self-conscious emotion (rising to 59% at 30–40 months).

The studies reviewed here confirm that the onset of mirror self-recognition is associated with changes children's in cognitive and social outlook. However, given that it is logical to infer the impossibility of linguistic and emotional self-reference without awareness of the referent (the self), correlations between the two might be perceived as circular. Likewise, although studies tracking the timeline of developments back to self-recognition may offer a clearer suggestion of a causal relationship, they do not constitute an experimental method. The research reviewed above raises a host of alternative routes to the study of early self-awareness (linguistic, emotional, physical), many of which are potentially less time limited and categorical (pass/fail) than mirror self-recognition. Yet very few scholars have looked beyond the mirror

mark test for an *experimental* measure of self-recognition. As noted, we hope to address this gap by developing a new experimental measure of the functional impact of self-recognition, taking the SRE paradigm as a starting point. To support this aim, the following section outlines the links that have previously been made between the self and memory in early childhood.

## SELF-RECOGNITION AND EPISODIC MEMORY IN DEVELOPMENT

Just as a logical link can be made between self-recognition and linguistic and emotional self-reference, a logical link can be made between self-recognition and autobiographical memory. An autobiographical memory can be defined as an episodic memory in which the self is acknowledged as the “experiencer” of the event—in other words, memory for a specific event in which self-recognition, or self-reflection, is a basic component. The earliest remembered life events occur between 2 and 8 years, with an established average of around 3.5 years (Pillemer & White, 1989; Usher & Neisser, 1993). However, research strongly suggests that from at least 6 months of age, infants’ actions are influenced by past visual-cognitive experiences. Infants who passively witness an adult playing with an unfamiliar object in a novel way will later play with the object in the same manner (Collie & Hayne, 1999; Meltzoff, 1995). This implies that although we do not remember early life events as adults, as infants we were able to encode and retrieve information about past events. Howe and colleagues (Howe & Courage, 1993, 1997; Howe et al., 2003) suggest that the onset of mirror self-recognition, roughly coinciding with the earliest retrospective memory reports, offers a clear explanation for this “infantile amnesia.” Until children are consciously aware of themselves as distinct from others, it is presumably impossible for them to “tag” memories as their own, and so organize or retrieve them as part of a personal life narrative. By this account, although infants know something about past events (as shown by Meltzoff, 1995, and Collie and Hayne’s, 1999, research), they may not explicitly remember these events as something that happened to them. Importantly, for an adult to remember details of an event that happened to them as a child, a link between the adult and child self must be maintained. It is not clear how this link could persist if the event details were not originally encoded as self-referent.

In support of this, Howe et al. (2003) tracked children between the ages of 15 and 23 months and found that those who achieved mirror self-recognition performed reliably better than non-self-recognizers at finding a toy hidden up to 12 months before. Similarly, Harley and Reese (1999) conducted a longitudinal study of verbal memory for past real-life events in conjunction with measures of self-recognition (the mirror test) and reminiscing styles (extent of elaboration about past events between mother-child dyads) between the

ages of 19 and 32 months. The results supported a significant role for both mother-child conversational factors and the extent of self-recognition, with the latter being a better predictor for strong verbal memory. However, as noted, correlating two logically related abilities (in this case self-recognition and memories of the self) might be perceived as insufficient evidence for a causal relationship. Moreover, neither study explicitly measured self-reference. It is conceivable that one could encode information about past events and even talk about aspects of an event in detail (particularly if supported by prompting) without explicitly acknowledging/representing the role of self. On this reading, Howe et al. (2003) and Harley and Reese (1999) may avoid circularity but fail to tap autobiographical memory. The same criticism can be made of Fivush et al. (1984) and Hammond and Fivush's (1991) narrative research. These studies did not separate verbal self-reference from verbal reference to other aspects of the event. For this reason, without the benefit of hindsight (as provided by asking an adult to retrieve early memories), it is debatable if these episodic memories can be considered part of an "autobiographical" system.

The SRE paradigm offers a way to avoid this difficulty, providing a measure that directly taps self-representation in memory. In adults, the SRE has typically been studied by contrasting memory for adjectives judged to be self-descriptive relative to those processed without reference to the self (see Symons & Johnson, 1997, for a meta-analysis). However, studies referring to a "subject-performed task effect" (SPT) might also be considered a type of SRE. The SPT effect refers to a memory bias for statements about actions that have been acted out relative to actions recited verbally or witnessed being performed by others (see Engelkamp, 1998, for review). Brief definitions of SRE and SPT effects are reproduced in Textbox 1, for the reader's reference. As noted, the SRE is thought to be based on encoding to-be-remembered stimuli with an often accessed and highly elaborated concept, the self. By contrast, those researching the SPT effect in adults generally consider it to be based on lower level proprioceptive feedback unique to the embodied self. However, echoing our discussion of the "dissected" self, research with children suggests that cognitive and physical SREs may not be so easily separated. This is important because typically formed autobiographical memories seem likely to draw on both physical and cognitive aspects of personal experience.

- The term self-reference effect (SRE) refers to a memory bias for material that has been judged self-relevant at encoding.
- The term subject-performed task (SPT) effect refers to a memory bias for actions that have been physically performed by the self.

TEXTBOX 1.—Definition of mnemonic "self-reference" effects.

One piece of evidence that implies that the SRE and SPT effects may be confounded in real-life situations comes from Millward, Powell, Messer, and Jordan (2000). They tested free- and verbally prompted recall for target events experienced during a 25-min walk by children with and without a diagnosis of autism. Half of the target events were experienced by the child; the remainder by a companion. Millward et al. (2000) found that after they had returned from the walk, typically developing 5- to 6-year-olds remembered and expressed more information relating to aspects of the event they had actively experienced; that is, they showed an SPT effect. However, children of the same verbal mental age diagnosed with autism showed the opposite bias, recalling more information about the experiences of their companion. Confirming that asymmetrical performance is not due to a lack of proprioceptive engagement, Summers and Craik (1994) reported that children with a diagnosis of autism remember more self-performed than self-verbalized actions. This suggests that the reversal of the SPT effect in children with autism is traceable to a difference in cognitive focus, rather than a difference in the depth of processing of actions.

Evidence supporting a cognitive component for the SPT effect can also be found in typically developing children, in whom the bias for self- versus other-performed actions is tempered by the extent of cognitive identification with "other." Baker-Ward, Hess, and Flannigan (1990) asked 5- to 8-year-old children to take turns performing 21 actions with objects and later to recall the actions made. Children were questioned immediately after the play session and again 3 weeks later. Some of the children were also questioned about the event in the intervening weeks. Baker-Ward et al. (1990) found that regardless of timeframe, repeated questioning, or age, children showed greater recall of actions they had performed relative to those they had observed being performed by classmates. However, in a second experiment, Baker-Ward et al. (1990) showed that the mnemonic advantage for self-performed actions disappeared when compared to memory for actions performed by the children's most regular playmates. Conceivably, self-performed actions were well remembered due to subjective feedback, whereas actions performed by highly familiar others benefited from association with an elaborated person-concept. However, it is difficult to see how cognitive familiarity could play a role for others' actions, but not for own.

Millward et al.'s (2000) and Baker-Ward et al.'s (1990) research suggest that higher level cognition plays a mediating role when comparing memory for self- and others' actions. For this reason, investigation of the functional effect of self-reflection on memory need not preclude action-based paradigms. Indeed, in addition to being more ecologically valid, the use of a physical activity (e.g., play) seems better suited to developmental research than the complex processing of word lists typically used in SRE studies. Nevertheless, researchers using the standard SRE paradigm have had some success

in demonstrating an effect in young children. For example, Bennett and Sani (2008) recently demonstrated an SRE for trait descriptions in 5-, 7-, and 10-year-olds. Children recalled more simple adjectives (clever, friendly, funny, greedy, happy, messy, naughty, noisy, small, and rough) that had been processed with the question “Do you think you are \_\_\_\_\_?” than those processed semantically (“Do you think \_\_\_\_ means the same as \_\_\_\_?”). Pullyblank, Bisanz, Scott, and Champion (1985) reported similar results in 7- and 10-year-olds. Like the research on the SPT effect reviewed earlier, neither of these SRE studies uncovered a significant interaction between mnemonic self-bias and age; the effects of self-involvement thus appear to be present in children as young as 5 years.

Interestingly, Bennett and Sani (2008) found that answering the question “Do you think people in your family are \_\_\_\_\_?” also led to better recall than did semantic processing. This effect, reminiscent of the equalizing effects of familiarity found by Baker-Ward et al. (1990), has been repeatedly found in SRE studies using adults. This has led to the criticism that mnemonic self-bias is premised on familiarity, as opposed to self-awareness (see Symons & Johnson, 1997). However, social research strongly suggests that identification with a social group (consisting of familiar others) is a major aspect of an elaborated self-concept (see Bennett & Sani, 2008; Johnson et al., 2002). In other words, both self-processing and familiar other processing engage one’s cognitive identity. Moreover, it is not clear how self-awareness and familiarity could be separated; the self is, by definition, uniquely familiar. Likewise, given the continuous link the self provides between encoding and retrieval conditions, it is arguably in a unique position to facilitate memory. Most important, whatever the “specialization” of the underlying mechanism, the minimum requirement for a cognitive SRE is self-recognition.

Using a paradigm especially designed to circumvent the complexity of trait adjectives and semantic judgements, Sui and Zhu (2005) provided evidence that SREs occur in children as young as 5 years old. Those authors presented 4-, 5-, and 10-year-old children with pictures showing various objects being pointed to by a generic figure. To manipulate self-referencing, this figure was altered to include a photograph of either the child’s own or an unfamiliar child’s face. For each presentation, the child was asked to report who was pointing to the object. After a short distraction task, Sui and Zhu (2005) introduced a surprise recall test. They found that although all age groups were above chance in monitoring who had pointed to the objects they recalled, only 5-year-olds named significantly more of the objects associated with their self-image than those associated with the other image. Ten-year-olds showed a nonsignificant bias toward self-referent material and 4-year-olds a nonsignificant bias in the opposite direction. Sui and Zhu (2005) went on to demonstrate that when the task demands were sufficiently challenging for 10-year-olds, they also showed a significant SRE.

However, although studies using the SPT and SRE paradigm imply that the autobiographical organization of memories is underway in early childhood, the majority cannot claim to have measured the expression of autobiographical memories. To make the step from implicit cognitive representation of self (indexed as a bias) to explicit cognitive representation of the self, another measure is required. Specifically, it is necessary, as achieved by Sui and Zhu (2005), to determine if children can explicitly differentiate the role of self and other in the event memories expressed. With both measures in place one can build a strong case for the “real-time” measurement of autobiographical memory. This is important because it removes the need to rely on adults retrospective reports of childhood events to categorize the memory as autobiographical. For this reason, careful application of the SPT/SRE paradigm could revolutionize investigation of the ontogeny of the autobiographical system.

## THE CURRENT RESEARCH

The six studies introduced earlier suggest that the SRE paradigm can be usefully applied to investigate the development of memory and self in both typically and nontypically developing children. However, each of those studies was conducted in relative isolation, with different objectives. By contrast, the seven studies that follow aim to provide an integrated body of work, elucidating the mechanism underlying typically developing SRE and SPT effects, their relation to autobiographical memory, and their implications for functional self-recognition. In keeping with these aims, the research was conducted using a population for which the extent of self-recognition and autobiographical processing requires further exposition. The target age range for comparison was between 3 and 4 years. This demographic was targeted because typically developing children’s ability to self-recognize (a basic requirement for the SRE) linguistically, emotionally, and in mirrors and photographs can be safely assumed in children by the age of 3 years. Further, although this developmental stage has been identified as the first to support lasting autobiographical memories, there is controversy concerning 3-year-olds’ capacity to represent the self in the past. Importantly, in contrast to mirror self-recognition, the magnitude of any SRE/SPT effect found may be sensitive to developmental change in the preschool period. By developing paradigms that engaged self-reference appropriate to this age range, we hoped to advance knowledge in the field by exploring the following key questions:

1. Can children younger than 5 years show SREs? As far as we are aware, Sui and Zhu’s (2005) study was the first to directly assess the impact of self-recognition on memory in children younger than

5 years. Those authors concluded that prior to the age of 5 years, children's self-concept, although present, may not be sufficiently elaborated to have a functional effect on memory. However, as noted, adults report autobiographical details of events occurring between the ages of 3 and 4 years (Pillemer & White, 1989). This suggests that the impact of the self on the organization of event memories begins in the preschool years and that Sui and Zhu's (2005) conclusion is open to challenge.<sup>3</sup>

2. What forms of self-reference, if any, lead to mnemonic bias for preschoolers? The preceding discussion highlights that different forms of self-reference (e.g., physical or cognitive) may contribute to the SRE in real-life situations. However, the SRE has been measured in adults almost exclusively using the trait adjective paradigm. Although there are many studies on SPT effects, this literature has rarely been brought together. In Experiment 1, we assess memory for self-performed actions, in Experiments 2–4, we assess memory for actions visually associated with the self (through mocked up photographs), and in Experiment 5–7, we assess memory for objects cognitively associated with the self through ownership. By approaching the SRE from various perspectives, we hope to move forward the debate concerning the mechanism or mechanisms underlying this effect.
3. Can early SREs be related to autobiographical memory? Importantly, all of the previously discussed channels of self-reference (kinesthetic, visual, cognitive) are likely to contribute to autobiographical memories in a natural setting. As noted, the SRE paradigm has the potential to index both implicit and explicit autobiographical self-reference. When SREs occur in episodic memory (as indexed by free recall) and make explicit reference to the self (as indexed by explicit self-other differentiation within the memory), a strong case can be made for explicit autobiographical reflection. However, given our younger age range, we were reluctant to rely solely on a free recall and source-monitoring measures to assess children's event memories (as in previous SPT/SRE studies). In keeping with previous preschool research (Fivush et al., 1984; Hammond & Fivush, 1991; Harley & Reese, 1999), we wished to provide mnemonic support. Rather than provide verbal scaffolding (which would have been difficult given the relative simplicity of the to-be-remembered items), we achieved this by introducing a visual recognition test. This required children to choose familiar stimuli from a group of distracters. Note, although welcome from a task demands perspective, it is debatable



whether this measure can be considered to tap episodic (as opposed to semantic) memory.

4. Is there developmental change in SREs within this age range? Previous research suggests that between 5 and 10 years, there is little developmental change in the SRE (Baker-Ward, Hess, & Flannigan, 1990; Bennett & Sani, 2008; Millward et al., 2000; Pullyblank et al., 1985; Sui & Zhu, 2005). However, the ontogeny of SREs has yet to be explored in the preschool years. Research on the development of self-recognition has revealed that kinesthetic feedback (a feeling of agency stemming from contingency cues) precedes feature matching (visual self-recognition in mirrors and photographs), which precedes more complex cognitive self-recognition (as involved in self-conscious emotions). It is possible that a similar developmental pattern might be evident for mnemonic self-recognition; we may see a staggered onset of effects from kinesthetic, to visual, to cognitive. Moreover, Povinelli et al.'s (1996) results suggest that 3-year-olds may struggle to refer to the self in the past, at least without training (Skouteris et al., 2006; Skouteris & Robson, 2006). On this account, SRE/SPT effects may be absent in younger children, not due to a generally unelaborated self-concept but due to a self-specific retrieval failure. There may also be a distinction to be drawn in the onset of explicitly self-referent memories (where the child remembers having performed the action or judged the stimuli as self-referent) and implicit self-referent memories (where the child reports no personalized memory of the event, but the "special" nature of self-referent memories is reflected by a recall or recognition bias). This would imply that infantile amnesia is not a problem of self-recognition, as argued by Howe and colleagues (Howe & Courage, 1993, 1997; Howe et al., 2003), but, as more traditionally held, a problem of expression.
5. Finally, and perhaps most important, how can using the SRE paradigm with preschoolers add to current knowledge concerning the development of self? For example, we are interested in exploring whether mnemonic self-bias (physical, visual, cognitive) implies not only self-recognition but also self-conservation. This may help us to qualify the adaptive nature of self-recognition. Not only do individual self-referent memories have survival value, but they also may play a formative role in maintaining the feeling of continuity (and so value) attached to personal identity. Although this might be particularly apparent when memories are explicit

and so contribute to a life narrative, implicit representation of the self may also play a role in promoting positive feelings of familiarity. Of importance, then, the SRE paradigm has the potential to index a cognitive-behavioral consequence of self-recognition congruent with the evolutionary and developmentally powerful implications of self-awareness.

## METHODOLOGICAL NOTE

In total, 456 preschool children were recruited, with parental consent, from 17 mixed demographic nurseries in Scotland. In most cases, testing took place in a separate room within the nursery building. Each study used a roughly equal number of boys and girls. The research used a variety of methods, described in full for each experiment. Means ( $M$ ) and standard deviations ( $SD$ ) are reported for relevant data (in figures,  $SD$  are shown as error bars). All statistical analyses are two-tailed and where possible exact  $p$  values are reported. To ensure the recognition data are a valid reflection of memory, performance is assessed using one-sample  $t$  tests. Chance performance is set at 25% for recognition tests and 50% for source monitoring (including ownership assignment) for all experimenters aside from the final experiment, where chance performance in the recognition test was set at 33%. Mixed models analyses of variance (ANOVAs) are used to investigate the impact of age group, and, where appropriate experimental conditions, on memory. In Experiment 4, which uses only one age group, Pearson's correlations are used to explore age effects. For all ANOVAs, partial eta squared ( $\eta_p^2$ ) is presented as an estimate of effect size. This value can be interpreted following Cohen (1969):  $\eta_p^2 > 0.2$  large,  $> 0.1$  medium, and  $> 0.05$  small. To aid clarity, only significant and marginally nonsignificant ( $p < .1$ ) results are reported in full.

## NOTES

1. Physical self-monitoring might be used to get rid of parasites or to boost attractiveness, thus improving evolutionary fitness. However, self-monitoring is possible without conscious awareness of the self, which is cognitively costly. For this reason, superficial self-monitoring is unlikely to be the primary evolutionary motivator for self-recognition.

2. The term *self-conservation* is used here and throughout this monograph, as used by Povinelli, Landau, and Perrilloux (1996) to refer to the link between self in the present and self in the past. Conceiving of the self as extending into the future is another aspect of self-conservation and is not addressed by the current research.

3. See Chapter III for further discussion of Sui and Zhu's (2005) methods and results.

## II. THE IMPACT OF PHYSICAL SELF-REFERENCE ON PRESCHOOLERS' MEMORY FOR DEPICTED ACTIONS

In the first experiment, we aimed to determine if, like adults, 3- and 4-year-old children, show better memory for actions they have physically performed than actions they have witnessed being performed. As noted, this “SPT effect” is generally held to occur due to kinesthetic elaboration of the to-be-remembered action that comes from self-performance. Compared to cognitive elaboration of to-be-remembered action (the SRE), this might be considered a low-level effect. For this reason, we might expect the SPT effect to emerge first, making it a plausible starting point for exploring the “earliest” self-reference effects. However, the traditional SPT paradigm, focusing on free recall of previously encountered actions, has high linguistic demands. To reduce these demands for our young sample, we included a visual record of the actions performed in the encoding session, which was reintroduced at retrieval. Specifically, each action was modeled by a cartoon actor. This allowed children’s free recall of the stimuli to be supplemented with a recognition measure. Such measures are important because young children are likely to be relatively poor at narrative encoding and retrieval, particularly of primarily perpetually based events (see Simcock & Hayne, 2002).

As noted, previous research with school-age children (Baker-Ward, Hess, & Flannigan, 1999; Millward et al., 2000) suggests that cognitive aspects of self-reference can encroach on the SPT effect. To determine if this also occurs for preschool children, we included some cognitive cues to self-reference. Actions were modeled by a cartoon peer, either a little boy or a little girl. Concepts of own gender and age group are among the first aspects of self-knowledge expressed (Stipek et al., 1990). To stimulate identification with gender-matched peers, this character was given the same name as the child. This explicit label provides one of the simplest entry points to activate self-recognition. Not only is one’s own name highly (if not uniquely) familiar, it is also inextricably linked, postobjective self-awareness, with the idea of “me.”

When physically involved in an event, 5-year-olds have been shown to maintain self-bias in event memory up to 3 weeks later (Baker-Ward et al., 1990). If preschoolers could also maintain an SRE or SPT effect in long-term memory, this would strengthen the theoretical link to the autobiographical

system. Finding SRE and SPT effects of different magnitudes or onsets in the same age range would imply that SRE and SPT effects are functionally distinct. In the current paradigm, as children sometimes perform actions modeled by the self-referent character, and sometimes by the other-referent character, cognitive and physical aspects of self-reference are in direct competition. As a result, we would expect a relatively strong bias for the physical or cognitive dimension to mask effects in the other dimension. On the contrary, finding evidence of both effects in both age groups would suggest that a multifaceted autobiographical system is already established.

## EXPERIMENT 1

### *Method*

#### *Participants*

Forty-five children took part: 23 3-year-olds ( $M = 37.7$  months,  $SD = 3$  months, range = 31–42 months) and 22 4-year-olds ( $M = 50.9$  months,  $SD = 5.2$  months, range = 43–59 months). Ten additional children (6 3-year-olds and 4 4-year-olds) were excluded due to failure to follow the procedure for taking turns in action reenactment.

#### *Materials*

The experimental stimuli at encoding consisted of an introductory drawing of two preschool children (one male and one female) standing side by side and facing the viewer, and two sets of 18 A6 action cards (including 2 practice cards) depicting these children performing an action. In each set, half of the actions were depicted by the boy and half by the girl. The actions depicted by each character were counterbalanced across sets.<sup>4</sup> At retrieval, one of two sets of 16 A4 recognition cards was used, selected to match the action cards used at encoding. Each recognition card depicted four actions (of the same type) performed by the same actor, one of which had been introduced at encoding. All actions were comparably simple to perform and familiar to preschool children. Examples of the stimuli used are shown in Figure 1.

#### *Procedure*

In the first session, children were introduced to the two cartoon characters on the introductory card (order counterbalanced). The default names of the



Introductory card



Example modeled action cards



Example action recognition cards

FIGURE 1.—Examples of Experiment 1 encoding and retrieval stimuli.

characters were Mary and Bob. However, children were routinely told that the character of their own gender shared their own name. So, for example, for a child named Louisa, the first session would commence: “Today we’re going to see Louisa and Bob do lots of different things then we’re going to take turns acting just like them.” To ensure they understood the procedure,

children were shown two practice action cards and instructed: “Let’s have a practice. Here is Louisa clapping, and here is Bob standing on one leg. I am going to clap my hands, just like Louisa (perform action). Can you stand on one leg just like Bob?” (or vice versa). Having successfully completed this practice phase, children were praised and reminded only to perform actions when prompted by the experimenter. As noted, children were excluded if they failed to follow this instruction.

In the encoding phase, children were presented with action cards one at a time in random order: “Look! In this picture *name is description of action*,” and instructed either to perform the modeled action or watch the experimenter perform it. The procedure was counterbalanced so that child and experimenter each performed half of the actions modeled by the male child and half by the female child. When all of the action cards had been presented, the children were praised for their participation and given a sticker as a reward.

One week later, children were reintroduced to the drawings of the actors and reminded of the previous session: “Do you remember last time I was here and we met a little girl called Louisa and a little boy called Bob? Can you remember any of the things we saw them do last time?” After responding to this free recall question, children were told that they were going to be shown some drawings to help them remember more about the previous session. A total of 16 recognition cards were introduced one at a time in random order. As noted, each recognition card showed one of the actors performing four actions, one of which had been presented at the previous session. After each of the actions on the recognition card was described briefly, the child was asked “Can you remember which of these things we saw X doing last time?” When all of the recognition cards had been presented, the children were again praised and given a sticker as a reward.

### *Analysis*

One-sample *t* tests were used to determine if recognition memory was above chance. A two-level (actor and performance) two-factor (self-related vs. other-related) repeated-measures ANOVA with age group as a between-subjects variable was used to explore recognition memory.

### *Results*

#### *Recall*

Only seven children (all 4 years old) spontaneously reported any of the 16 target actions from the encoding session. Of the children reporting

explicit memories of the previous session, four recalled two of the 16 target actions and three recalled only one. The low incidence of action recall precludes statistical analysis; however, of the 11 actions recalled, the majority (7) were self-related on both encoding dimensions (performance and model).

*Recognition*

As shown in Table 1, recognition performance was significantly above chance overall for both age groups and on all encoding dimensions.

Age significantly affected the total number of actions recognized,  $F(1, 43) = 9.5, p = .03, \eta_p^2 = 0.18$ . Specifically, 4-year-olds recognized more target actions than did 3-year-olds. There was a significant mnemonic advantage for both self-performed actions,  $F(1, 43) = 7.2, p = .011, \eta_p^2 = 0.15$ , and actions modeled by a self-referent actor,  $F(1, 43) = 4.96, p = .031, \eta_p^2 = 0.11$ . These medium effect sizes are similar to the typical effect size found in Symons and Johnson's (1997) meta-analysis of SRE effects. Neither self-related bias interacted with age.

TABLE 1

EXPERIMENT 1 RECOGNITION PERFORMANCE SPLIT BY AGE GROUP AND ENCODING DIMENSION

| Recognition          | Overall  | Age Group   |   |
|----------------------|--|---|---|
|                      |  | 3-Year-Old  | 4-Year-Old  |
| Overall              | $M = 7.3$ (46%),<br>$SD = 3.4$<br>$(t(44) = 6.4, p < .001)$  | $M = 5.9$ (37%),<br>$SD = 2.9$<br>$(t(22) = 3.1, p = .005)$ | $M = 8.8$ (55%),<br>$SD = 3.3$<br>$(t(21) = 6.7, p < .001)$ |
| Self-performed       | $M = 4$ (50%),<br>$SD = 2.1$<br>$(t(44) = 6.5, p < .001)$    | $M = 3.2$ (40%),<br>$SD = 1.7$<br>$(t(22) = 3.2, p = .004)$ | $M = 4.9$ (61%),<br>$SD = 2.1$<br>$(t(21) = 6.5, p < .001)$ |
| Other-performed      | $M = 3.2$ (40%),<br>$SD = 1.8$<br>$(t(44) = 4.7, p < .001)$  | $M = 2.7$ (34%),<br>$SD = 1.6$<br>$(t(22) = 2.1, p = .04)$  | $M = 3.9$ (49%),<br>$SD = 1.8$<br>$(t(21) = 4.7, p < .001)$ |
| Model self-referent  | $M = 3.9$ (49%),<br>$SD = 2$<br>$(t(44) = 6.3, p < .001)$    | $M = 3.2$ (40%),<br>$SD = 1.7$<br>$(t(22) = 2.3, p = .04)$  | $M = 4.7$ (59%),<br>$SD = 2.1$<br>$(t(21) = 6.1, p < .001)$ |
| Model other-referent | $M = 3.4$ (42%),<br>$SD = 1.75$<br>$(t(44) = 5.3, p < .001)$ | $M = 2.7$ (34%),<br>$SD = 1.5$<br>$(t(22) = 2.2, p = .035)$ | $M = 4.1$ (51%),<br>$SD = 2.6$<br>$(t(21) = 5.8, p < .001)$ |

*Note.*—No children performed at ceiling.

## Discussion

Experiment 1 provides evidence of a mnemonic advantage for self-related material in preschool children. Three- and 4-year-old children showed a significant bias for recognizing stimuli that were related physically (through performance) or cognitively (through nominal/gender matching) to themselves at encoding. This confirms that both SRE and SPT effects have an earlier onset than suggested by previous research (Baker-Ward et al., 1990; Bennett & Sani, 2008; Millward et al., 2000; Pullyblank et al., 1985; Sui & Zhu, 2005; Summers & Craik, 1994). As noted, if the SPT effect was based entirely on subjective feedback, then one might expect it to precede the “objective” SRE in ontogeny. However, Experiment 1 found SPT and SRE effects of equivalent magnitude, with no significant developmental progression. It is notable that both effects emerged despite being pitted against one another (the cognitive SRE controlled for physical self-reference and vice versa). This result fits with previous research suggesting that SRE and SPT effects have some mechanistic overlap (Baker-Ward, Hess, & Flannigan, 1999; Millward et al., 2000).

The current paradigm evidently has high memory demands. Within this sample, none of the younger preschoolers offered free recall of the event. However, the introduction of picture recognition tests provided a useful support. Although there was developmental progression in recognition memory, both 3- and 4-year-olds were above chance in reporting memories of encoding using this measure. In addition to reducing the delay between encoding and retrieval, one way to reduce the mnemonic demands of this paradigm would be to reintroduce objects involved in actions at encoding, as opposed to actor-object models. This would reduce the visual complexity of the recognition tests and, more important, as objects are more easily labeled than action statements, ease the linguistic demands of free recall. This method gave Summers and Craik (1994) a positive result for 5-year-old children and is adopted in the remaining experiments reported in this volume.<sup>5</sup>

An alternative way to simplify the actor-object model, particularly important for tests of cognitive SREs, would be to use a less ambiguous self-referent actor. Although children as young as 2 years recognize themselves in photographs, the understanding of drawings as representations emerges later, sometime between the 3rd and 4th year (Zelazo, Sommerville, & Nichols, 1999). As a result, we might question whether children identified with the to-be-remembered cartoon representation in Experiment 1. Rather, the SRE found may have been based on the novelty of being presented with a cartoon counterpart. Where actors and objects are represented separately, this problem can easily be avoided by representing self- and other-referent actors using a recently taken photograph. Accordingly, Experiments 3, 4, and 5 use instant Polaroid images of self and other to create self- and other-referent contexts at encoding.<sup>6</sup>



In addition to highlighting these design problems, the clearest limitation of Experiment 1 is that it permits no comment on children's *explicit* reference to the self in the past. As we included no measure of source monitoring, it remains possible that the role of the self in memory is not open to conscious reflection for preschool children. Using the current paradigm, it might have been possible to gather data on explicit awareness of the past self by asking children to report at retrieval which actor modeled an action or who performed it. However, asking children to source-monitor on both physical and cognitive dimensions would arguably be overly demanding ("I performed it but he modelled it."). Advantageously, as a result of separating actors and to-be-remembered objects, and the introduction of unambiguous people representations, the following experiments are amenable to self-other source-monitoring checks (e.g., "Was X presented with your photograph?"). By asking children to recall contextual information concerning the self at encoding, this form of source monitoring allows us to determine whether preschool children can make explicit reference to the self in episodic memory.

Finally, in the following chapters, although preserving an "action" paradigm, we move away from kinesthetic contributions to self-reference. Although we remain interested in the contribution of physical self-involvement to self-referent memories, this experiment suffices to confirm that such a contribution occurs and therefore must be controlled for if seeking to find a "purely" cognitive SRE of the sort reported in adult populations. We have previously commented on the wisdom of dissecting the self permanently. However, it is clear that cognitive self-awareness and basic kinesthetic awareness (agency) are both ontogenetically and phylogenetically distinct. Detection of agency appears to be innate in humans. In Chapter I, we reviewed a number of studies suggesting that newborn infants are sensitive to contingency between themselves and the environment prior to mirror self-recognition (Bahrick & Watson, 1985; Field, 1979; Legerstee et al., 1998; Lewis and Brooks-Gunn, 1979; Rochat & Striano, 2002). Research with nonhumans also suggests that agency detection is present in many species that do not show mirror self-recognition (see Mitchell, 2002, for an interesting discussion). This implies that the SPT effect may operate, at least partially, at an implicit level. For this reason, to focus on pinpointing the functional specialization of *explicit* self-recognition, it seems prudent to put kinesthetic agency temporarily aside.

## NOTES

4. An equal number of depicted actions could be categorized as self-directed (acts on self, with or without object), other-directed (actions directed away from self, with or without object), and actions with or without an imaginary object. Post hoc, these action categories appeared to have no influence on performance and so are not discussed in detail.

5. Another apparently simple way to support perceptual memory might have been to introduce reenactment of the action sequences at recall and recognition. Preschool children are capable of reenacting more actions from a previous activity than they can express verbally (Ratner, Foley, & McCaskill, 2001; Smith, Ratner, & Hobart, 1987). However, asking the children to enact actions at retrieval would introduce a cuing bias for self-performed actions. Only these actions would be experienced in the same mode (action) at encoding and retrieval; that is, only the target item would constitute reenactment. Even at recall, the instruction “show me an action from last time” is likely to preferentially cue actions that were previously “shown” by the child. For this reason, although reenactment is likely to prove useful in assessing the importance of the subjective aspect of the SPT effect (see Mulligan & Horstein 1999), it is unsuited to establishing its natural occurrence.

6. Although unambiguously self-referent, own names and photographs are also highly familiar, and likely to be attention grabbing. Further discussion of top-down, attention-based SREs is provided in Chapters III and V.

### **III. THE IMPACT OF VISUAL-COGNITIVE SELF-REFERENCE ON PRESCHOOLERS' MEMORY FOR ACTION OBJECTS**

In this chapter, we report three experiments in which the physical component of action encoding used in Experiment 1 is replaced with visual-cognitive processing tasks. Although making no reference to the SPT effect, Sui and Zhu's (2005) developmental SRE paradigm innovatively combines physical and cognitive aspects of self-reference. As noted, those authors asked children to recognize an external self-representation linked via a pointing gesture to to-be-remembered objects. The advantage of this procedure is that it exploits the simple and memorable nature of physical self-involvement, while requiring children to process stimuli on a cognitive basis. Moreover, during encoding and at retrieval, Sui and Zhu (2005) asked the children to monitor which actor (self or other) pointed to an object. This simple judgment is important as it confirms that the link between self and object is available on an explicit level. Interestingly, given their failure to find an SRE for 4-year-olds, Sui and Zhu (2005) found that 4-, 5-, and 10-year-old children were similarly equipped to differentiate between self and other in memory. For the objects they did recall, each age group showed a success rate of around 70% in reporting the actor with whom they were associated.

Success in this aspect of the task is in line with previous research suggesting that young children can monitor whether events were self- or other-produced. For example, Foley, Johnson, and Raye (1983) found that 6-year-olds were as accurate as adults in distinguishing whether they had spoken a word, or if it had been spoken by another person. Extending these results, Sui and Zhu (2005) demonstrated that 4-year-olds can explicitly encode information differentiating between the roles of self and other on a visual-cognitive basis. Implying that SREs may rely on explicit self-recognition, some researchers have found that children with autism are impaired in self-other source monitoring (Hala, Rasmussen, & Henderson, 2005; Russell & Jarrold, 1999). However, as the 4-year-olds' performance in self-other source-monitoring was equivalent to that of older age groups in Sui and Zhu's (2005) study, this factor cannot explain why they failed to show an SRE.

Interpreting this failure, Sui and Zhu (2005) suggest that despite their ability to self-observe, younger children's self-concepts may be

underdeveloped relative to older children's. As a result, the association of to-be-remembered stimuli with the younger children's self-concepts is inadequate to induce a bias at retrieval. This conclusion is in line with our suggestion that the SRE paradigm has the potential to index developmental change in the cognitive elaboration of the self-concept. However, Sui and Zhu (2005) went on to conclude that the self has no functional role in memory for younger children. This conclusion does not necessarily follow. Although tagging objects as self-referent was yet to be of mnemonic benefit, the self-concept nonetheless had a mnemonic impact in differentiating the material, that is, it had a function. Moreover, Experiment 1 shows that in other conditions, preschool children can show a bias in memory for events associated with the self-concept.

It is possible that the difference between the findings of Experiment 1 and Sui and Zhu's (2005) results is due to the higher task demands of our experiment. The external self-representation used in Experiment 1 was not a direct reflection of the child, meaning that any association between the self-concept and to-be-remembered stimuli required cognitive mediation. It is perhaps counterintuitive that this more complex level of self-recognition should allow 4-year-olds to index an SRE, whereas Sui and Zhu's (2005) simpler procedure did not. However, Sui and Zhu's (2005) task relied on making explicit a visual link between self and stimuli, whereas Experiment 1 required that the link between self and stimuli be actively constructed. This occurred either via physical involvement or cognitive interpretation of otherwise neutral stimuli as self-related. For this reason, Experiment 1 may have elicited deeper self-referent processing than Sui and Zhu's (2005) task. One interpretation then, is that to elicit an effect one must ensure that younger children actively elaborate the link between self and to-be-remembered stimuli. Without this, any link made may be too weak to be of cognitive benefit.

An alternative explanation for the disparity between our results and Sui and Zhu's (2005) findings focuses on the specific task demands of their study. Although the association between self and stimuli in Sui and Zhu's (2005) study appeared simple, their method for ensuring children encoded this information was not. First, they used hybrid stimuli for self-recognition, digitally placing children's heads on a generic pointing body. Although the children were evidently able to correctly differentiate between self and other in declarative memory, it is a peculiarity of Sui and Zhu's (2005) procedure that representation of the pointing action was divorced from the actor involved. This may have compromised self-other differentiation on an implicit level. Moreover, this problem might have been particularly pronounced for the younger children, whose understanding of external representations is relatively new (Zelazo et al., 1999). Of further detriment to implicit self-other differentiation, Sui and Zhu (2005) used the image of an unfamiliar other of the same age and gender as the child. However, Experiment 1 showed

that observable similarities between self and other sometimes led preschool children to show a mnemonic bias for “other”-referent stimuli.

The complexity of Sui and Zhu’s (2005) presentation schedule is also open to criticism. At encoding, representations of actor and object were presented on screen for just 4 s before the display disappeared to be replaced by a source-monitoring prompt. During the prompt (which was displayed for an unlimited time), the child was encouraged to state the sentence “I am” or “Other is” “pointing to the *object*.”<sup>7</sup> These minitests of declarative memory served to emphasize the link between actors and objects, and were presumably designed to support the encoding of expressible memories. Consequently, children spent most of their time not experiencing the impact of self-recognition, but recreating this experience verbally. For developing linguists in particular, these minitests might have distracted from continued elaboration on a deeper level. The cognitive correlates of visual self-recognition are presumably activated most strongly during the recognition event, not after it.

Sui and Zhu (2005) justify their separation of visual and linguistic processing by noting that children cannot be expected to respond on a strict schedule. However, they do not discuss their motivation for using a fixed interval to present visual stimuli. Their use of a shorter interval in the second study, which aimed to increase task difficulty for 10-year-olds, implies that this factor was intended to make the task sufficiently challenging to allow an SRE. In Symons and Johnson’s (1997) meta-analysis, short presentation times were found to increase SREs. However, as discussed, brief presentation time in this paradigm might reduce the cognitive impact of self-recognition. It is also possible that the fixed interval was introduced to ensure that children spent an equivalent amount of time exposed to self- and other-referent stimuli. Symons and Johnson (1997) did not flag within-task timing as an issue in studies of the SRE in adults. Further, our own comparison of studies with ( $N = 28$ ) and without ( $N = 41$ ) fixed interval presentation times in Symons and Johnson’s (1997) meta-analysis suggests that this factor does not dictate whether an effect occurs. However, as with the picture stimuli used in Experiment 1,<sup>8</sup> the word stimuli used in these studies were objectively self-neutral. By contrast, Sui and Zhu’s (2005) stimulus-object pairs were transparently self-referent. For this reason, Sui and Zhu (2005) might have considered it important to control for the amount of time allowed to make simple visual associations.

However, even if stimuli were presented on a schedule dictated by responses, it is unclear how a selective time bias would emerge, particularly in the direction needed to support an SRE. The most likely scenario is arguably that self-interest would lead to fast responding to self-referent questions, which would undermine any time-driven SRE. If self-interest led to slow responding due to distraction, failing to focus on the link between self and stimuli (the response required) would also undermine the SRE. If

preschoolers chose to withhold answers to the self-referent question not because they were unsure of them but because of a desire to prolong exposure, they would be showing an unlikely amount of Machiavellian control. In any event, the motivation to linger over stimuli presented with the self-image would remain indicative of higher level self-recognition. Moreover, to confer mnemonic benefit, extra processing time must refer not only to the self but also to the to-be-remembered object. At the very least then, concurrent activation of the object-concept and self-concept would be central to the mnemonic bias. It would be difficult to argue that this was not an SRE.

## EXPERIMENT 2

Sui and Zhu's (2005) approach is of particular interest as it identifies an unambiguous aspect of self-reference that might be used to trace the ontogeny of the SRE, and to assess explicit self-monitoring in event memory. It is clear that 3- and 4-year-olds recognize their self-image. What is not clear is whether the cognitive correlates of visual self-recognition are strong enough to play a supportive role in memory. Having identified some complexities in Sui and Zhu (2005) procedure, Experiment 2 aims to determine if the paradigm can be adapted to allow younger children to show an SRE. Addressing concerns about a possible recognition overlap between self and other, Experiment 4 substituted Sui and Zhu's (2005) same-gender peer photograph with a photograph of the experimenter. To avoid ambiguity concerning action ownership, full body shots of self and experimenter pointing were used. Crucially, children were asked to judge who was pointing to the object *during* stimulus pair presentation. Here, the linguistically simple response "I am" or "You are," or even a gesture toward the appropriate person was sufficient. When children made a response, the stimulus pair was removed. Finally, as in Experiment 1, the recall test was supplemented by a recognition measure designed to support the children's reporting of visual memories of the event.

Sui and Zhu's (2005) use of a very short interval between encoding and retrieval is typical of the SRE paradigm and is replicated here. Given that a primary aim of these experiments is to provide the first evidence of an SRE in preschool children, it is unnecessary to require children to demonstrate the SRE over a substantial delay (as in Experiment 1). Moreover, large delays are likely to be particularly challenging without the support of physical involvement in the event, as used in previous long-delay research (Baker-Ward et al., 1990). In any case, according to the currently held SRE model, stimuli that are recognized as self-referent at encoding are linked to the self-concept. This greater depth of processing results in the stimuli becoming relatively easy to retrieve. Encoding specificity (the self is present at both encoding

and retrieval) may also contribute. However, the initial recognition of stimuli as self-referent is at the root of the effect. Likewise, the initial encoding of stimuli as self-referent is presumably the first step in autobiographical processing. For this reason, although future research could usefully address the impact of increasing delay on the SRE in adults and preschoolers (see also Experiments 6 and 7 in this volume), Experiments 2, 3, and 4 are committed only to replicating the effect with the typical delay.

### *Method*

#### *Participants*

Sixty preschool children took part: thirty 3-year-olds ( $M = 38.6$  months,  $SD = 1.9$  months, range = 35–42 months) and thirty 4-year-olds ( $M = 49.4$  months,  $SD = 4.2$  months, range = 44–57 months).

#### *Materials*

During encoding, one of two Polaroid photographs was placed on A4 sheets of paper on a target approximately one inch from an object outline picture. Photograph and objects were arranged so that the person in the picture (child or experimenter) appeared to be pointing at the object (see, e.g., Figure 3). Ten sheets, each featuring a different object, were presented, five with self-image and five with other-image. As in Sui and Zhu's (2005) study, object outline pictures were taken from a set standardized for familiarity by Snodgrass and Vanderwart (1980). A4 recognition cards consisted of one target object and three distracter objects (see Figure 2). Three paper cups and a toy-shopping trolley were used in a distracter activity separating encoding from retrieval.

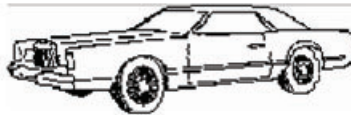
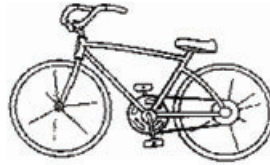
#### *Procedure*

Children were shown a Polaroid image of the experimenter pointing, after which they were asked to adopt a pointing pose and had their own Polaroid photograph taken. In the encoding phase, 10 object outlines were shown one at a time with one of the Polaroid images held adjacent (order counterbalanced). Sui and Zhu (2005) used 12 object pictures, but piloting suggested that 10 was a more appropriate number of stimuli for this younger sample. During each stimulus-pair presentation, the experimenter pointed to the object and said "What is that?", and the child typically answered with the



"I am pointing to the bike"

Example of encoding stimuli



Example of recognition stimuli

FIGURE 2.—Examples of Experiment 2 encoding and retrieval stimuli.



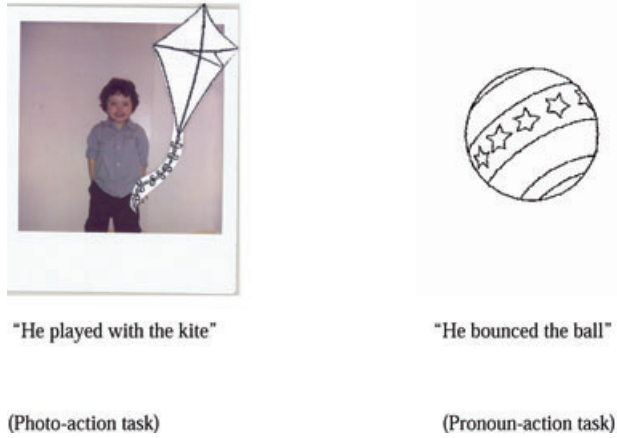


FIGURE 3.—Examples of Experiment 3 encoding stimuli.

object name (if they did not, the experimenter named the said “it’s an X [e.g., *ball*], isn’t it?”). The experimenter then pointed to the adjacent photograph and said “Who is pointing to the X?” The target response was “I am” or “You are,” or a gesture toward the appropriate person. If the child refused to respond, the experimenter said “You are/I am pointing to the *object*,” while gesturing to the appropriate person, and then moved on.

Following encoding of all 10 objects, the child participated in a 2-min-long distracter activity involving hiding a toy from the experimenter under one of three cups. Sui and Zhu (2005) did not provide details of their distracter task, but the present activity was of similar duration and unrelated to the picture game. After the interval, the child was reminded of the previous game (verbally, and via reintroduction of the photographs) and asked to recall the object pictures shown. For each object correctly recalled, the child was asked the explicit source-monitoring question “Who pointed to the X?” This time the target response was “I did” or “You did,” or a gesture toward the appropriate person or photograph (both were present). Children were then given a recognition test for each object. Recognition cards showed objects from the previous display together with three distracters (placement on card counterbalanced). The experimenter named each object on the card and said “I only showed you one of these pictures, can you remember which one?”. Again, for each object correctly recognized, the child was asked “Who pointed to the X?”, target responses were as for the recall test. At the end of the game, children were given their own photograph to keep as a reward for taking part.

## Analysis

One-sample *t* tests were used to determine if recognition memory and source-monitoring judgments were above chance. A univariate ANOVA with age group as a between-subjects factor was used to assess the impact of age on source-monitoring accuracy for recognized stimuli. A two-factor (self-referent vs. other-referent) repeated-measures ANOVA with age group as a between-subjects variable was used to explore recognition memory.

## Results

### Recall

Only 15 children (three 3-year-olds and twelve 4-year-olds) offered free recall, recalling an average of 2.2 objects ( $SD = 1.4$ ). At an average of 69.4% ( $SD = 40\%$ ) correct source-monitoring judgments for recalled stimuli, performance narrowly failed to significantly exceed chance,  $t(14) = 1.8$ ,  $p = .08$ . The low incidence of recall precludes statistical analysis. However, of the 33 stimuli recalled, 15 were self-referent and 18 were other-referent.

### Recognition

As shown in Table 2, recognition performance was significantly above chance overall, for both self- and other-referent stimuli, and for both age-groups.

Age had no effect on overall recognition rates. Within the task, children recognized a similar number of self- and other-referent stimuli. However, this factor interacted with age,  $F(1, 58) = 6.6$ ,  $p = .012$ ,  $\eta_p^2 = 0.1$ . To investigate

TABLE 2

EXPERIMENT 2 RECOGNITION PERFORMANCE SPLIT BY AGE GROUP AND ENCODING DIMENSION

| Recognition    | Overall  | Age Group  |  |
|----------------|--|--|--|
|                |  | 3-Year-Old   | 4-Year-Old   |
| Overall        | $M = 5.3$ (53%), $SD = 2.9$<br>$(t(59) = 7.4, p < .001)$ | $M = 4.8$ (48%), $SD = 2.8$<br>$(t(29) = 4.3, p < .001)$ | $M = 5.8$ (58%), $SD = 2.9$<br>$(t(29) = 6.2, p < .001)$ |
| Self-referent  | $M = 2.5$ (50%), $SD = 1.6$<br>$(t(59) = 6.2, p < .001)$ | $M = 2.5$ (50%), $SD = 1.6$<br>$(t(29) = 4.1, p < .001)$ | $M = 2.6$ (52%), $SD = 1.6$<br>$(t(29) = 4.7, p = .001)$ |
| Other-referent | $M = 2.7$ (54%), $SD = 1.6$<br>$(t(59) = 7.3, p < .001)$ | $M = 2.3$ (46%), $SD = 1.4$<br>$(t(29) = 4, p < .001)$   | $M = 3.2$ (64%), $SD = 1.6$<br>$(t(29) = 6.7, p < .001)$ |

Note.—Five 3.5- to 4-year-olds performed at ceiling, recognizing all 10 stimuli.

further, the file was split according to age group and the ANOVA repeated with no between-subjects variable. As shown in Table 2, whereas 3-year-olds recognized a similar number of self- and other-related objects, 4-year-olds showed a strong bias for recognition of other-related objects,  $F(1, 28) = 7.5$ ,  $p = .011$ ,  $\eta_p^2 = 0.2$ .

Children made correct source-monitoring judgments for an above-chance average of 61.5% ( $SD = 29\%$ ) of recognized stimuli,  $t(58) = 3$ ,  $p = .004$ . Although the effect of age on the percentage of correct source monitoring failed to reach significance,  $F(1, 55) = 3.2$ ,  $p = .08$ ,  $\eta_p^2 = 0.05$ , one-sample  $t$  tests indicated that whereas 3-year-olds did not significantly differ from chance in monitoring the source of recognized stimuli at 55%, 4-year-olds were above chance at 68% ( $SD = 24\%$ ,  $t(29) = 4$ ,  $p < .01$ ).

### *Discussion*

Four-year-olds performed above chance in monitoring who had pointed to recognized objects, confirming that this age group is capable of explicitly differentiating between self and other in memory. However, 4-year-olds did not recognize self-referent stimuli more often than other-referent stimuli at retrieval. Just as in Sui and Zhu's (2005) recall data, they showed a bias in the opposite direction, recognizing more stimuli associated with the image of an unfamiliar other. Moreover, in this experiment, 4-year-olds' mnemonic bias for other-referent stimuli was significant. The results for 3-year-olds are also negative. Here, 3-year-olds failed to show a significant SRE, despite the shorter interval between encoding and retrieval. Further, children of this age were below chance in monitoring the source of the stimuli they did recognize.

The replication of Sui and Zhu's (2005) other-reference effect (ORE) confirms that 4-year-olds' failure to index an SRE was not due to those authors' use of a similar other or generic representation of the pointing action. Even when given the opportunity to focus for longer on self-referent stimuli, 4-year-olds showed no SRE. However, children showed the same pattern here where exposure to photographs was longer, as in Sui and Zhu's (2005) study, where they were presented for only a few seconds. This refutes the suggestion that the fixed interval schedule might have been overly demanding for 4-year-olds. Nevertheless, discovery of a significant ORE challenges Sui and Zhu's (2005) conclusion that 4-year-olds failed to show an SRE due to a relatively weak self-concept. There is no reason to expect that 4-year-olds' concepts of unfamiliar others should be superior to their own, albeit early, self-concepts.

A more plausible explanation for the ORE can be derived from previous discussion of self-focus. As noted, one reason to include a fixed interval stimulus presentation schedule is to control for self-interest as a mediating factor in a visual-cognitive SRE. However, in addition to a possible impact on the time spent encoding self- versus other-referent stimuli, self-focus might

have an impact within stimulus presentations. Specifically, photographs were presented separately from to-be-remembered objects in the visual field, and the integration between the two was relatively passive (pointing). For this reason, it seems plausible that self-photographs sometimes distracted from, rather than drew attention toward, task stimuli. Clearly, this could result in a reversed self-reference effect. This might also explain why the expected age-related recognition advantage emerged only for other-referent stimuli. Only here could 4-year-olds encode stimulus-object pairs without distraction.

### EXPERIMENT 3

Following the above reasoning, Experiment 3 introduced two SRE paradigms in which the impact of visual self-focus was controlled. The first aimed to more clearly integrate to-be-remembered stimuli with representations of self and other. To achieve this, objects were placed upon, rather than adjacent to, person photographs. The objects were chosen to give the impression of an action. For example, a cut out tennis racket placed upon a figure in a photograph gives the impression that the figure is playing tennis. Placing to-be-remembered objects in the same visual field as the self was expected to minimize any interference arising from self-focus. Moreover, it seemed likely that the elaborated link between people and objects would result in a greater depth of processing. Experiment 1 suggested that active processing might help young children to show an SRE. To ensure that children actively interpreted the link between people and objects, they were asked to give a verbal description of actor and action (e.g., “I played tennis”) during stimulus presentation. This additional support was expected to facilitate 3-year-olds’ source monitoring, improving the possibility of an SRE for this age group.

Rather than integrate self- and object-representations, the second paradigm returned to the use of self-neutral stimuli. Here, objects were presented with a verbal action description only. Crucially, each description began with linguistic reference to self (“I”) or other (“He/She”). To compensate for the paucity of these presentations, descriptions no longer focused on the generic “played with” but described specific actions, for example “I stroked the cat.” First-person pronouns are reflexive, meaning that depending on the context of their production, they may refer to self or other. As such, “I” does not yield an attention or familiarity advantage over “you,” “he,” or “she” in the way that one’s own name (Experiment 1) or own photograph (Experiment 2) might yield an advantage over less-familiar names or images. However, this theoretical advantage has practical implications. As the children were not of reading age, action statements had to be presented verbally in the pronoun-based task. This meant that the first-person pronoun used in action statements could be interpreted as referring to the speaker (an other)

as opposed to the listener. For this reason, children were required to repeat action statements, in other words, to verbally take the perspective of "I." To address the possibility that action statement repetition might not be sufficient to prompt children take the cognitive perspective of "I" a second variable was introduced to promote self-referent processing: specifically, half of the children were exposed to their mirror image during encoding.

In adults, the introduction of a mirror has been shown to result in an increased tendency to interpret ambiguous language as self-referent (Davis & Brock, 1975; Stapel & Tesser, 2001). This raises the possibility that a mirror may encourage children to interpret the first-person pronoun employed in Experiment 3 as self-referent, thus promoting an SRE. Even in the photo-based version of the task, where first-person pronouns are disambiguated, it seems possible that any increased activation of the self-concept resulting from mirror exposure would facilitate an SRE. For this reason, the introduction of a mirror to the SRE paradigm might be expected to help children, particularly the youngest age group, index an effect.

## *Method*

### *Participants*

In total, 120 preschool children took part: sixty 3-year-olds ( $M = 38.5$  months,  $SD = 2.3$  months, range = 34–42 months) and sixty 4-year-olds ( $M = 49.5$  months,  $SD = 4.4$  months, range = 43–59 months). Half of the children from each age group completed the photo-action task and half the pronoun-action task (total  $N$  per task = 60).

### *Materials*

Stimuli for the photo-action task included three Polaroid photographs (one of the child, one male child, and one female peer) and 10 cutout object outlines as described for Experiment 2. Stimuli for the pronoun-action task were the same 10 object outline pictures, this time accompanied by an action statement to be read out by the experimenter. See Figure 3 for examples of photo-action and pronoun-action encoding stimuli. A mirror (6" × 6") was also used at encoding to manipulate self-awareness. As described for Experiment 2, recognition stimuli for both tasks comprised 10 A4 recognition cards including one target object and three previously unencountered objects. Materials and procedure for the distracter task were as described in Experiment 2.

## *Procedure*

Children participating in the photo-action task were shown a Polaroid photograph of a child of the opposite gender, then had their own photograph taken. For half of the children, a mirror was present and angled to reflect the child's face (high self-awareness condition). For the remainder, the mirror's nonreflective surface was presented (low self-awareness condition). Those in the high self-awareness condition had their attention drawn to their mirror image while waiting for the photograph to develop ("Can you see yourself in my mirror? Is that what your photograph will look like?"). Children were asked to self-recognize in the photograph, which was then shown with a series of stimulus-pair presentations. During the presentation, each object was placed upon one of the Polaroid images (order counterbalanced), and the child was asked "What's that?" and "Who is playing with the X?" Upon response, the experimenter prompted "So you say, I (He/She) am (is) playing with the X" and encouraged the child to repeat the sentence.

Photographs of unfamiliar opposite-gender peers replaced the experimenter's image in this paradigm to avoid confusion arising from the reflexive nature of personal pronouns ("I" becomes "You"). Contrary to Sui and Zhu (2005), an opposite-gender peer was used, intended to maximize differentiation between self and other. As described in Experiment 2, following a short distracter activity, the child was reminded of the previous game and asked to recall, recognize, and source monitor for the object pictures shown. The mirror was not present at retrieval in order to avoid any bias in cuing self-referent information. Again, children were given their own photograph to keep at the end of the game as a reward for participation.

Children participating in the pronoun-action task were presented with the same object pictures. Again, children in the mirror condition were encouraged to attend to their reflection before the task began. In this task, as each object was shown, the experimenter made a simple action statement involving the object and the first-person pronoun "I" or an opposite-gender referent pronoun (e.g., "I/He bounced the ball"). Here, the generic "played with" was not used to describe actions as, in the absence of photographs, this might not result in sufficient differentiation between encoding stimuli. Following the short distracter task, the child was reminded of the previous game and asked to recall and recognize the object pictures shown as described in Experiment 2 (again the mirror was now absent). In pilot work, children failed to respond to the simplest framing of the source-monitoring question, for example, "What did we say about the ball?" or "Who bounced the ball?" For this reason, source-monitoring questions were not asked for the pronoun-action task. At the end of the game, children were given a sticker as a reward for taking part.

### *Analysis*

One-sample *t* tests were used to determine if recognition memory and source-monitoring judgments in the photo-action task were above chance. A univariate ANOVA was used to assess the impact of age and self-awareness condition on source monitoring for recognized stimuli in the photo-action task. Performance here was compared to source-monitoring performance in Experiment 2 using an independent samples *t* test. A two-level (recall and recognition) two-factor (self-referent vs. other-referent) repeated-measures ANOVA with age group, task type, and self-awareness condition as between-subjects factors was used to explore memory performance. To get a clearer picture of what was going on within each task (allowing neater comparison of this data with previous results), repeated-measures ANOVA with age and self-awareness condition as between-subjects variables were also run separately on recognition scores for each task type.

### *Results*

#### *Recall*

Fifty children (eighteen 3-year-olds and thirty-two 4-year-olds) offered free recall, recalling an average of 2.9 objects ( $SD = 1.4$ ). Age had a main effect on overall recall scores,  $F(1, 112) = 10.4$ ,  $p = .002$ ,  $\eta_p^2 = 0.08$ , with 4-year-olds ( $M = 1.7$ ,  $SD = 1.4$ ) outperforming 3-year-olds ( $M = 0.8$ ,  $SD = 1.9$ ). There was no recall advantage for either task type (photo-action task:  $M = 1.1$ ,  $SD = 1.6$ ; pronoun-action task:  $M = 1.3$ ,  $SD = 1.8$ ) or self-awareness condition (mirror present:  $M = 1.2$ ,  $SD = 1.6$ ; mirror absent:  $M = 1.4$ ,  $SD = 1.8$ ). Moreover, children showed no recall advantage for self- ( $M = 0.6$ ,  $SD = 0.9$ ) over other-related ( $M = 0.6$ ,  $SD = 1$ ) stimuli, regardless of age-group, task type, or self-awareness condition.

Source monitoring for those offering free recall in the photo-action task was remarkably high at 97.5% ( $SD = 8\%$ ) correct,  $t(24) = 27.9$ ,  $p < .01$ . However, the relatively small number offering free recall precluded statistical assessment of the effects of age and self-awareness condition on source-monitoring performance.

#### *Recognition*

As shown in Table 3, recognition was above chance for both tasks, for both age groups, and self-awareness conditions.

TABLE 3  
 EXPERIMENT 3 RECOGNITION PERFORMANCE SPLIT BY TASK, ENCODING DIMENSION, AGE GROUP, AND SELF-AWARENESS CONDITION

| Recognition                | Overall   | Age Group  |  |  | Self-Awareness Condition                                   |           |  |
|----------------------------|---|--|--|--|--|-----------|--|
|                            |   | 3-Year-Old   | 4-Year-Old   |  | Mirror   | No Mirror |  |
| <b>Photo-action task</b>   |   |  |  |  |  |           |  |
| Overall                    | $M = 7$ (70%), $SD = 2.9$<br>( $t(59) = 11.8, p < .001$ )   | $M = 6.5$ (65%), $SD = 2.9$<br>( $t(29) = 7.5, p < .001$ ) | $M = 7.5$ (75%), $SD = 3$<br>( $t(29) = 9.3, p < .001$ )   | $M = 7$ (70%), $SD = 2.9$<br>( $t(29) = 8.3, p < .001$ )   | $M = 7.1$ (71%), $SD = 3.1$<br>( $t(29) = 8.2, p < .001$ ) |           |  |
| Self-referent              | $M = 3.6$ (72%), $SD = 1.6$<br>( $t(59) = 11.5, p < .001$ ) | $M = 3.5$ (70%), $SD = 1.6$<br>( $t(29) = 7.7, p < .001$ ) | $M = 3.7$ (74%), $SD = 1.6$<br>( $t(29) = 8.4, p < .001$ ) | $M = 3.6$ (72%), $SD = 1.6$<br>( $t(29) = 7.9, p < .001$ ) | $M = 3.6$ (72%), $SD = 1.6$<br>( $t(29) = 8.1, p < .001$ ) |           |  |
| Other-referent             | $M = 3.4$ (68%), $SD = 1.5$<br>( $t(59) = 10.7, p < .001$ ) | $M = 3$ (60%), $SD = 1.5$<br>( $t(29) = 6.4, p < .001$ )   | $M = 3.8$ (76%), $SD = 1.5$<br>( $t(29) = 9.2, p < .001$ ) | $M = 3.4$ (68%), $SD = 1.4$<br>( $t(29) = 7.9, p < .001$ ) | $M = 3.4$ (68%), $SD = 1.8$<br>( $t(29) = 7.2, p < .001$ ) |           |  |
| <b>Pronoun-action task</b> |   |  |  |  |  |           |  |
| Overall                    | $M = 5.9$ (59%), $SD = 3.5$<br>( $t(59) = 7.6, p < .001$ )  | $M = 4.9$ (49%), $SD = 3.4$<br>( $t(29) = 3.9, p < .001$ ) | $M = 6.9$ (69%), $SD = 3.3$<br>( $t(29) = 7.2, p < .001$ ) | $M = 5.4$ (54%), $SD = 3.6$<br>( $t(29) = 4.5, p < .001$ ) | $M = 6.4$ (64%), $SD = 3.3$<br>( $t(29) = 6.3, p < .001$ ) |           |  |
| Self-referent              | $M = 3.2$ (64%), $SD = 1.7$<br>( $t(59) = 8.2, p < .001$ )  | $M = 2.6$ (52%), $SD = 1.7$<br>( $t(29) = 4.5, p < .001$ ) | $M = 3.6$ (72%), $SD = 1.7$<br>( $t(29) = 7.4, p < .001$ ) | $M = 2.9$ (58%), $SD = 1.7$<br>( $t(29) = 5.4, p < .001$ ) | $M = 3.3$ (66%), $SD = 1.8$<br>( $t(29) = 6.3, p < .001$ ) |           |  |
| Other-referent             | $M = 2.8$ (56%), $SD = 1.9$<br>( $t(59) = 6.4, p < .001$ )  | $M = 2.3$ (46%), $SD = 1.8$<br>( $t(29) = 3, p = .005$ )   | $M = 3.4$ (68%), $SD = 1.8$<br>( $t(29) = 6.5, p < .001$ ) | $M = 2.5$ (50%), $SD = 2$<br>( $t(29) = 3.5, p = .01$ )    | $M = 3.1$ (62%), $SD = 1.8$<br>( $t(29) = 5.7, p < .001$ ) |           |  |

Note.—Thirty-five children (twenty-six 4-year-olds and nine 3-year-olds) performed at ceiling, recognizing all 10 stimuli.



Age had a significant effect on the number of stimuli recognized,  $F(1, 112) = 6.7, p = .01, \eta_p^2 = 0.06$ , with 4-year-olds outperforming 3-year-olds. Recognition memory appeared more robust in the photo-action task, and the between-subjects effect of task type approached significance,  $F(1, 112) = 3.6, p = .058, \eta_p^2 = 0.03$ . There was no effect of self-awareness condition on recognition scores.

Children showed a significant recognition advantage for self- ( $M = 3.4, SD = 0.15$ ) over other-related ( $M = 3.1, SD = 0.15$ ) stimuli,  $F(1, 112) = 7.7, p = .006, \eta_p^2 = 0.065$ , regardless of task type or self-awareness condition. This SRE interacted with age,  $F(1, 112) = 5, p = .03, \eta_p^2 = 0.04$ , such that 3-year-olds showed the largest bias (3-year-olds: self-related  $M = 3.1, SD = 0.2$ , other-related  $M = 2.6, SD = 0.2$ ; 4-year-olds: self-related  $M = 3.65, SD = 0.2$ , other-related  $M = 3.6, SD = 0.2$ ).

Within the photo-action task, there was no overall recognition advantage for self-related stimuli; however, there was a significant interaction between this factor and age,  $F(1, 56) = 5.6, p = .02, \eta_p^2 = 0.09$ . As shown in Table 3, 3-year-olds showed a stronger SRE than 4-year-olds. To qualify this, the file was split according to age group and the analysis repeated without age group as a between-subjects factor. This analysis showed that whereas 3-year-olds showed a strong SRE in the photo-action task,  $F(1, 28) = 8.1, p = .008, \eta_p^2 = 0.2$ , 4-year-olds failed to show a significant bias in either direction.

Within the pronoun action there was a significant overall advantage for self-referent stimuli,  $F(1, 56) = 5.4, p = .02, \eta_p^2 = 0.09$ , with no interaction with age or self-awareness condition. However, there was a significant three-way interaction between the SRE, self-awareness condition, and age,  $F(1, 56) = 5.4, p = .02, \eta_p^2 = 0.09$ . To investigate further, the file was again split by age group and the analysis repeated without age group as a between-subjects factor. Three-year-olds,  $F(1, 28) = 5.1, p = .03, \eta_p^2 = 0.15$ , but not 4-year-olds showed a significant overall SRE (see Table 3 for means). Moreover, this bias interacted with self-awareness condition,  $F(1, 28) = 5.1, p = .03, \eta_p^2 = 0.15$ . As shown in Figure 4, 3-year-olds showed a bias for stimuli encoded with first-person pronouns within the task only when the mirror was present at encoding,  $F(1, 14) = 16, p = .001, \eta_p^2 = 0.5$ ; when the mirror was absent they showed no recognition bias.

At an average of 89% ( $SD = 18.5\%$ ) correct, source monitoring for recognized stimuli in the photo-action task was significantly improved from Experiment 2 (independent sample  $t$  test,  $t(113) = 5.7, p < .01$ ). Moreover, one-sample  $t$  tests indicated that both age groups were now significantly above chance at monitoring the source of recognized stimuli (3-year-olds:  $M = 84\%, SD = 24\%, t(26) = 7.4, p < .01$ ; 4-year-olds:  $M = 92\%, SD = 11\%, t(28) = 19.8, p < .01$ ). There was no effect of age or self-awareness condition

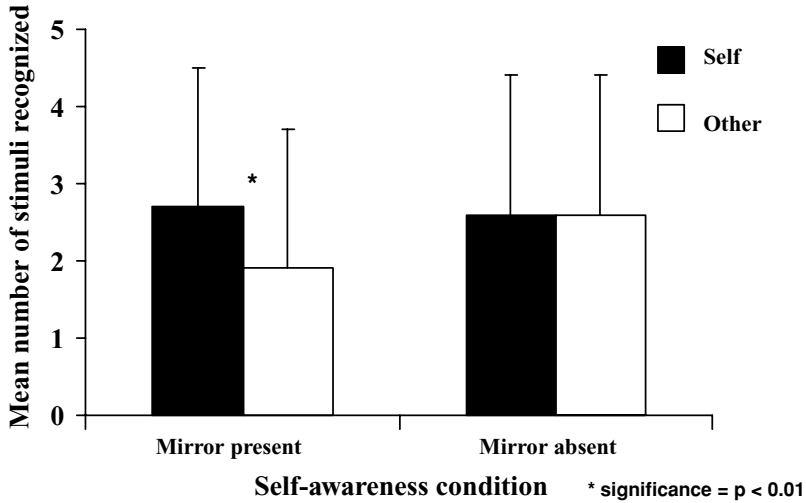


FIGURE 4.—Three-year-olds’ recognition of self- and other-referent stimuli in Experiment 3, split by self-awareness condition.

(mirror present:  $M = 83\%$ ,  $SD = 22\%$ ; mirror absent:  $M = 92\%$ ,  $SD = 12\%$ ) on source-monitoring performance.

### Discussion

Experiment 3 provides new evidence to suggest that children as young as 3 years show an SRE in memory. Three-year-olds showed greater recognition of stimuli that had been presented *pictorially* as part of a self-performed action. This occurred regardless of mirror-induced self-focus at encoding. However, children only showed a bias for the recognition of stimuli that *verbally* implicated the self when self-focus was primed by the mirror. Both results indicate that helping 3-year-olds to actively link events with the self at encoding can facilitate retrieval of those events. However, no SRE was found for 4-year-olds. A plausible explanation for this lies in older children’s greater recognition success. Over 40% of the 4-year-olds in both tasks performed at ceiling when recognizing encoding stimuli. This means that a relatively small number of 4-year-olds were capable of showing differential recognition of self-versus other-referent stimuli. By contrast, only 15% of 3-year-olds performed at ceiling. A similar problem was encountered by Sui and Zhu (2005), who, although finding an SRE for 5-year-olds in their first experiment, failed to find an equivalent effect for 10-year-olds. This problem was overcome in their second experiment by increasing the number of to-be-remembered stimuli. Following Sui and Zhu’s (2005) reasoning, Experiment 4 aimed to increase

task demands to increase the likelihood that 4-year-olds would show a significant SRE.

## EXPERIMENT 4

### *Method*

#### *Participants*

Sixty 4-year-olds took part: 30 in the photo-action task ( $M = 51$  months,  $SD = 5$  months, range = 43–60 months) and 30 in the pronoun-action task ( $M = 54.2$  months,  $SD = 6$  months, range = 43–63 months).

#### *Materials and Procedure*

The materials and procedure were as described for Experiment 3. However, to increase difficulty, six extra object outline pictures and recognition cards were now included, bringing the total number of to-be-remembered stimuli to 16. Again, all object outlines were taken from Snodgrass and Vanderwart's (1980) standardized set.

#### *Analysis*

One-sample  $t$  tests were used to determine if recognition memory and source-monitoring judgments in the photo-action task were above chance. A univariate ANOVA was used to assess the impact of self-awareness condition on source monitoring for recognized stimuli in the photo-action task. Pearson's correlations were run to assess the impact of age on overall recall and recognition rates. A two-level (recall and recognition) two-factor (self-referent vs. other-referent) repeated-measures ANOVA with task type and self-awareness condition as between-subjects factors was used to explore memory performance. For recognition data, repeated-measures ANOVAs with age and self-awareness condition as between-subjects variables were also run separately for each task type. Finally, analysis was run to compare the magnitude of SREs found for 3- and 4-year-olds in this and the previous experiment, these are described in full later.

## Results

### Recall

Thirty-nine children ( $M = 54$  months) offered free recall, recalling an average of 2.7 objects ( $SD = 1.4$ ). Recall scores did not show a significant correlation with age in months and neither task type (photo-action task:  $M = 1.8$ ,  $SD = 1.6$ ; pronoun-action task:  $M = 1.7$ ,  $SD = 1.8$ ) nor self-awareness condition (mirror present:  $M = 1.9$ ,  $SD = 1.9$ ; mirror absent:  $M = 1.5$ ,  $SD = 1.5$ ) had significant main effects. There was no recall advantage for self- ( $M = 0.8$ ,  $SD = 0.9$ ) over other-referent ( $M = 0.9$ ,  $SD = 1.1$ ) stimuli, regardless of task type, or self-awareness condition.

In the photo-action task, an above-chance average of 87% ( $SD = 27\%$ ) of source judgments, arising from free recall was correct,  $t(19) = 5.9$ ,  $p < .01$ . However, the relatively small number offering free recall precluded statistical assessment of the effects of age and self-awareness condition on source-monitoring performance.

### Recognition

As shown in Table 4, recognition was above chance for both tasks, and for all self-awareness and encoding conditions.

Recognition scores were significantly positively correlated with age in months ( $r^2 = .26$ ,  $p = .04$ ). However, neither task type nor self-awareness condition had a significant main effect on recognition.

Children showed a significant recognition bias for self- ( $M = 6.5$ ,  $SD = 0.2$ ) over other-related ( $M = 6$ ,  $SD = 0.3$ ) stimuli,  $F(1, 58) = 6.2$ ,  $p = .016$ ,  $\eta_p^2 = 0.1$ , regardless of task type (photo-action task: self-referent  $M = 6.3$ ,  $SD = 0.4$ , other-referent  $M = 5.7$ ,  $SD = 0.4$ ; pronoun-action task: self-referent  $M = 6.7$ ,  $SD = 0.4$ , other-referent  $M = 6.4$ ,  $SD = 0.4$ ) or self-awareness condition (mirror present: self-referent  $M = 6.5$ ,  $SD = 0.3$ , other-referent  $M = 5.9$ ,  $SD = 0.4$ ; mirror absent: self-referent  $M = 6.5$ ,  $SD = 0.3$ , other-referent  $M = 6.3$ ,  $SD = 0.4$ ). A three-way interaction between the SRE, task type, and self-awareness condition approached but did not reach significance,  $F(1, 58) = 2.9$ ,  $p = .09$ ,  $\eta_p^2 = 0.05$ .

Within the photo-action task, children showed a significant bias for self-referent stimuli,  $F(1, 28) = 4.6$ ,  $p = .04$ ,  $\eta_p^2 = 0.1$ , regardless of self-awareness condition. In contrast, the overall SRE in the pronoun-action task was not significant. However, as found for 3-year-olds in Experiment 3, there was a significant interaction between self-reference effects and self-awareness condition,  $F(1, 28) = 4.9$ ,  $p = .035$ ,  $\eta_p^2 = 0.15$ . As evident in Table 4, and confirmed by independent analysis, 4-year-olds showed a strong bias for self-referent

TABLE 4

EXPERIMENT 4 RECOGNITION PERFORMANCE SPLIT BY TASK TYPE, ENCODING DIMENSION, AND SELF-AWARENESS CONDITION

| Recognition         | Overall   | Self-Awareness Condition                                     |   |
|---------------------|---|--|---|
|                     |   | Mirror   | No Mirror   |
| Photo-action task   |   |  |   |
| Overall             | $M = 12$ (75%),<br>$SD = 4.2$<br>$(t(29) = 10.2, p < .001)$     | $M = 12.2$ (76%),<br>$SD = 4.1$<br>$(t(14) = 7.7, p < .001)$ | $M = 11.9$ (74%),<br>$SD = 4.6$<br>$(t(14) = 6.6, p < .001)$  |
| Self-referent       | $M = 6.3$ (78%),<br>$SD = 2$<br>$(t(29) = 11.4, p < .001)$      | $M = 6.3$ (78%),<br>$SD = 2$<br>$(t(14) = 8.2, p < .001)$    | $M = 6.2$ (77%),<br>$SD = 2.1$<br>$(t(14) = 7.7, p < .001)$   |
| Other-referent      | $M = 5.7$ (71%),<br>$SD = 2.4$<br>$(t(29) = 8.3, p < .001)$     | $M = 5.9$ (74%),<br>$SD = 2.3$<br>$(t(14) = 6.4, p < .001)$  | $M = 5.6$ (70%),<br>$SD = 2.6$<br>$(t(14) = 5.3, p < .001)$   |
| Pronoun-action task |   |  |   |
| Overall             | $M = 13.1$ (81.8%),<br>$SD = 3.5$<br>$(t(29) = 14.1, p < .001)$ | $M = 12.6$ (79%),<br>$SD = 4$<br>$(t(14) = 8.3, p < .001)$   | $M = 13.6$ (85%),<br>$SD = 3.1$<br>$(t(14) = 12.2, p < .001)$ |
| Self-referent       | $M = 6.7$ (84%),<br>$SD = 1.8$<br>$(t(29) = 14.5, p < .001)$    | $M = 6.7$ (84%),<br>$SD = 1.8$<br>$(t(14) = 10, p < .001)$   | $M = 6.7$ (84%),<br>$SD = 1.8$<br>$(t(14) = 10.2, p < .001)$  |
| Other-referent      | $M = 6.4$ (80%),<br>$SD = 2$<br>$(t(29) = 12.1, p < .001)$      | $M = 5.9$ (74%),<br>$SD = 2.2$<br>$(t(14) = 6.7, p < .001)$  | $M = 6.9$ (86%),<br>$SD = 1.6$<br>$(t(14) = 12.1, p < .001)$  |

Note.—Eleven children ( $M = 54$  months) performed at ceiling, recognizing all 16 stimuli.

stimuli when the mirror was present at encoding,  $F(1, 14) = 9.3, p = .01, \eta_p^2 = 0.4$ . However, when the mirror was absent, they recognized a similar number of self- and other-referent stimuli.

At an average of 83% ( $SD = 17\%$ ) correct, children were significantly above chance at monitoring the source of recognized stimuli in the photo-action task,  $t(29) = 10.5, p < .01$ . There was no effect of self-awareness condition on accurate source monitoring (mirror present:  $M = 82\%, SD = 14\%$ ; mirror absent:  $M = 84\%, SD = 20\%$ ).

#### COMPARISON OF THE MAGNITUDE OF SIGNIFICANT SRE IN EXPERIMENTS 3 AND 4

In Experiment 3, 3-year-olds showed a significant recognition SRE, and this effect was replicated for 3.5- to 4-year-olds in Experiment 4. To confirm whether age had an impact on the magnitude of this effect, we brought together the relevant data (percentage of self- and other-referent stimuli

recognized by sixty 3-year-olds in Experiment 3 and sixty 3.5- to 4-year-olds in Experiment 4) and ran a two-factor (self- vs. other-referent) repeated-measures ANOVA, including age, task type, and self-awareness condition as between-subjects variables. This confirmed a significant overall SRE,  $F(1, 112) = 19.1, p < .001, \eta_p^2 = 0.15$ , with no interaction with age. The only significant interaction was between task type and self-awareness,  $F(1, 112) = 5.3, p = .02, \eta_p^2 = 0.045$ ; this reflected the role of the mirror in driving the SRE in the pronoun task.

### *Discussion*

Experiment 4 confirms that 4-year-olds show an SRE in memory when task demands are sufficiently high. Just as shown by 3-year-olds in Experiment 3, 4-year-olds showed a bias for the recognition of stimuli that had been presented pictorially or, provided they were self-focused, verbally as part of a self-performed action. As in Experiment 2, 4-year-olds proved adept at explicitly differentiating between the roles of self and other in an event after a short delay. Together then, Experiments 3 and 4 provide new evidence that preschool children show both explicit self-other differentiation in memory and an accompanying self-reference advantage. Although memory capacity generally increased with age, younger and older children both showed a significant self-bias of similar magnitude, providing task difficulty was calibrated to their abilities. This confirms that preschoolers' cognitive processing of events can be linked to, and is likely to mnemonically benefit from, the activation of self-awareness.

Note though, that although mirror-induced self-focus was expected to boost memory for "I" statements, inspection of the data reveals that this did not occur. Rather, the mirror-induced SRE appeared attributable to a decrease in recognition of other-referent stimuli (see Figure 4, Table 4). This result highlights an oversight in the developmental SRE literature. As in our experiments, most studies have relied on comparison of memory for self- and other-referent events experienced in tandem (five out of six developmental studies, i.e., Pullyblank et al., 1985; Baker-Ward et al., 1990; Summers & Craik, 1994; Millward et al., 2000; Sui & Zui, 2005; 77% of studies in Symons & Johnson's [1997] meta-analysis of studies with adults). Crucially though, when self-processing is qualified only in the context of other-processing, it is difficult to conclude that self-processing is independently superior. Rather, it may be that the introduction of self-focused attention detracts from nonself-referent processing. For example, in this study, it is difficult to determine whether self-photographs increased self-memories or decreased other memories, relative to the norm. Importantly, if the SRE is premised on the strength of the self-concept, self-processing should be superior to other-processing even when considered in isolation. One simple way to test this hypothesis is to

include an independent other-referent control. Another way to minimize the chances of an attention-based effect is to use objectively self-neutral stimuli (e.g., as achieved in trait description tasks). These design adjustments are incorporated in the final experiments, reported in the following chapter.

## NOTES

7. Although stimulus-object pairs were no longer available, Sui and Zhu (2005) reported that children stated who was pointing in the present tense and used the unnatural phrase "Other is." These idiosyncrasies might reflect translation problems because the study was conducted in Beijing. However, if children were required to use the unusual phrase "Other is," this novelty might explain why 4-year-olds found other-referent stimuli slightly more memorable. However, the results of Experiment 3 suggest this is not the full explanation.

8. Children's names might be considered directly self-reflective; however, in Experiment 1, the name referred to the cartoon, not to the child.

## IV. THE IMPACT OF SOCIO-COGNITIVE SELF-REFERENCE ON PRESCHOOLERS' MEMORY FOR OWNED OBJECTS

In Experiments 5, 6, and 7, visual links between self and objects are replaced with the cognitive link of object ownership. In encoding an object as “mine,” an explicit link is made between that object and oneself. Moreover, in recovering this link, one brings knowledge of the past self to bear on self-other differentiation in the present. This has led to the suggestion that accurately claiming ownership after a delay implies not only cognitive self-recognition but also self-conservation (Fasig, 2000). Despite these important implications, processing ownership appears less linguistically and socio-cognitively complex than processing trait adjectives. To judge a trait adjective as self-referent children must have the vocabulary to recognize the word and the insight to match it to the sum of their past behavior/state. By contrast to judge an owned object as self-related, they need only understand one word and one past relation, “mine.” Indeed, through observation of children at home or in play groups, it has been established that children as young as 2 years act as though they have an understanding of ownership.

Hay’s (2006) longitudinal data suggest that children begin to use the possessive pronouns “mine/yours” in spontaneous conversation with their peers by the age of 2 years. Further, Ross (1996) found that 2-year-olds were capable of making coherent arguments for ownership, distinguishing between current possession and past possession, when involved in toy disputes with siblings. Investigating how children typically acquire ownership information in social contexts, Friedman and Neary (2008) showed that 2- to 4-year-olds make implicit assumptions about ownership based on which story character first possessed an item. Providing further evidence that preschool children act appropriately on ownership information, Eisenberg-Berg and colleagues (Eisenberg-Berg, Haake, & Bartlett, 1981; Eisenberg-Berg, Haake, Hand, & Sadalla, 1979) reported that 2.5- to 3-year-olds given a novel toy and told it belongs to them defended this toy in a classroom situation to a greater extent than children given a toy with the instruction that it “belongs to the class.”

Of direct relevance to the claim that self-referent ownership information relies on self-awareness, Levine (1983) demonstrated that 2-year-old children scoring highly in personal pronoun production and comprehension



claimed and maintained contact with their own toys to a greater extent than less verbally accomplished peers. Contrary to nominal labels, the referents of pronominal forms constantly shift depending on speaker/listener roles (Bates, 1990). For this reason, personal pronoun production and comprehension requires a capacity to reflect on the self from the perspective of another, that is, a linguistic analog of mirror self-recognition. Indeed, as noted in the introductory chapter, objective self-awareness as measured by the mirror mark test predicts competency in personal pronoun use (Courage et al., 2004; Lewis & Ramsay, 2004). In further support, in autism difficulties with socio-cognitive self-awareness extend to problems in the acquisition and use of personal pronouns (Lee, Hobson, & Chiat, 1994; Tager-Flusberg, 1993). Note, though, that because “mine” is an extension of the “my/your” distinction, a correlation between personal pronoun competency and ownership as expressed verbally is hardly surprising. Despite this caveat, the link between children’s “territorial” toy behavior and their grasp of personal pronouns confirms that children are not only paying lip service to their agency. The extent to which children are self-defining in language is linked to their capacity to behaviorally mark items as their own.

Rather than observing peer interactions, Fasig (2000) sought to experimentally assess 2-year-olds’ ownership understanding by asking them to explicitly differentiate between objects based on ownership. To substantiate the link between ownership understanding and the self, she compared performance on this task with parental reports of children’s self-awareness (as measured by Stipek et al.’s, 1990, Self-Development Questionnaire) and performance in the mark test of mirror self-recognition. In the ownership task, children were first asked to label everyday items as belonging to themselves or their mother. For each object (toothbrush, book, shoe), two familiar exemplars and one unfamiliar example were shown. Children were given three ownership questions relating to these objects, each potentially earning one point: “Whose is this?” for child’s item, “Whose is this?” for mother’s item, and “Pick up the one that is yours.” Fasig (2000) also asked for ownership information concerning three differently colored blocks: One block was entirely novel, and two had been presented a few minutes before. To encode ownership information, one of these blocks had been repeatedly labeled as belonging to the child and the other as belonging to the experimenter.

When ownership scores for all four stimuli types (toothbrush, book, shoe, and block) were combined, 2-year-olds were found to be above chance in assigning ownership, scoring 77% correct. Fasig (2000) therefore suggested that self-conservation has an earlier ontogeny than implied by Povinelli et al.’s (1996) task. However, despite acknowledging the block task as the “most stringent test of ownership understanding”, and suggesting that it be analyzed separately (Fasig, 2000, p. 377), no such analysis was reported. It is difficult to distinguish whether children judging familiar items have explicit

knowledge of the object as belonging to them in the past, or if they are simply expressing a current, strong association. In contrast, ownership information for novel objects clearly requires explicit self-reference.

Perhaps as a result, Fasig's (2000) success in empirically linking performance in the ownership task with other measures of self-awareness was mixed. That author found a positive link between competency in the ownership tasks and children's use of descriptive and evaluative language concerning the self. In this 12-item facet of Stipek et al.'s (1990) scale, mothers rate their child's tendency to make descriptive claims beginning with "I am" or "Johnny is," extending to those that involve an aspect of evaluation (e.g., "I am bad") or desire (e.g., "I want chips"). Importantly, this suggests that the link between ownership claims and self-reflective language may extend beyond personal pronoun competency. There was also a moderate correlation with mothers' assessments of their child's self-recognition. However, no direct link between the mark test of mirror self-recognition and ownership performance was found.

In explanation, Fasig (2000) suggested that the external nature of mirror self-recognition might dissociate it from internalized measures of self-recognition such as ownership, linguistic self-reference, attention seeking, and the communication of desires. However, it is not clear how owning an object can be considered internalized to a greater extent than "owning" one's self-image, as implied by mirror self-recognition. Moreover, Lewis and Ramsay (2004) and Courage et al. (2004) showed longitudinally that internalized self-reflection, as indicated by personal pronoun use, can be related to mirror self-recognition. For these reasons, it appears more likely that the lack of association in Fasig's (2000) study reflected her failure to differentiate familiar and unfamiliar ownership information and a lack of power arising from coding mirror self-recognition on a binary basis (with the majority of the sample passing the task). The latter point highlights a limitation of the mirror mark test as a tool to validate increments in self-awareness beyond the onset of "me."

## EXPERIMENT 5

Building on Fasig's (2000) research, Experiment 5 aims to assess whether children can encode ownership information for recently acquired unfamiliar items at above-chance levels. To allow thorough assessment of their performance, children were asked to distinguish a total of eight items based on ownership. Moreover, prior to declaring ownership information, children were required to (a) recall stimuli or (b) recognize the stimuli in a group of previously unseen distracters. This ensured that children were accessing their memory of the previous session before making ownership judgments. To substantiate Fasig's (2000) suggestion that ownership claims make reference to

the past self, the delay between encoding of ownership information was increased from a few minutes to 1 week. Maintenance of ownership information beyond the present (or recent past) is important because it implies that the information has been encoded, and is explicitly retrievable, with reference to the self-concept.

To support the encoding of lasting ownership memories, Experiment 5 includes both verbal labeling of objects as belonging to self or other and active processing of this information. Specifically, children are asked to act on verbally presented ownership information by sorting the objects into distinct locations based on their owner. As highlighted in Experiment 1, participating actively in an event is likely to increase depth of processing and so aid retrieval of to-be-remembered material. However, to allow focus on higher level self-reference, children had equal physical experience of both owned and not-owned stimuli. By virtue of the theoretical link made between ownership memory and the self-concept, we expected that Experiment 5 might also be open to self-reference effects. The discovery of an ownership SRE would empirically consolidate the claim that owned items are associated with the self-concept.

Encouragingly, Cunningham, Turk, MacDonald, and Macrae (2008) have recently reported that adults given a surprise recognition test after sorting 216 shopping items into their own or a confederate's basket showed a mnemonic bias for owned items. In addition to this within-subjects effect, we might expect a between-subjects effect, showing a bias for objects sorted on the basis of self-referent ownership (mine/not mine) in comparison to those sorted in non-self-referent terms. Recall that Bennett and Sani (2008) found a difference between children who judged words in terms of whether they applied to the self and those who processed words in a non-self-reflective way. To explore the possibility of an "independent" SRE, Experiment 5 also includes a comparison group of children asked to retrieve stimuli and ownership information concerning two peers.

## *Method*

### *Participants*

Ninety preschool children took part: forty-five 3-year-olds ( $M = 38.9$  months,  $SD = 2.4$  months, range = 33–42 months) and forty-five 4-year-olds ( $M = 50.3$  months,  $SD = 4.7$  months, range = 43–59 months). Approximately half of the children from each age group completed a self-referent ownership task, and the remainder a non-self-referent version (total  $N$  per task = 45).

## *Materials*

At encoding, the experimental stimuli comprised eight A6 ownership cards depicting different animals and two boxes (one red and one blue) painted to resemble zoos. At retrieval, eight A4 recognition cards were introduced. Each recognition card showed one of the animals from the ownership cards together with three “distracter” animals that were not previously encountered. All animals were comparably drawn and pilot work confirmed that they were easily recognizable to preschool children. Examples of these stimuli are shown in Figure 5. In the non-self-referent version of the game, two Polaroid photographs of unfamiliar peers (one boy and one girl) were also included.

## *Procedure*

Throughout the procedure, the order of personal and other-referent pronouns and names (i.e., mine, my; yours, your; Billy, Mary) was counter-balanced. In the non-self-referent game Polaroid photographs, each showing the face of an unfamiliar child (“Mary” and “Billy”), were stuck to the front of the appropriate zoos. The procedure was introduced to children as follows: “Today we are going to look after some zoo animals. This zoo is Y’s (yours/Mary’s), and this zoo is Z’s (mine/Billy’s). I have some animals to share between the zoos. Some will be Y’s and some will be Z’s.”

Having introduced the task, the experimenter drew animal cards at random from the pack and said: “This is a(n) X (e.g., *elephant*) and it belongs to Y. The X lives in Y’s zoo.” The child was then asked to place the animal out of sight in the appropriate zoo. The experimenter proceeded: “This is a(n) X and it belongs to Z. The X lives in Z’s zoo.” Again, the child was asked to place the animal out of sight inside the appropriate zoo. This procedure continued until all eight animals had been assigned an owner (four animals per zoo). Placing the animals inside the zoos ensured that the next animal drawn from the pack was given full visual attention and helped to engage the children.

After distributing the animals, the experimenter removed the cards from each zoo (order counterbalanced) and laid them on the desk in front of their owners, saying, “So these are all of Y’s animals and these are all of Z’s animals. It is important that we know which animals belong to whom so that they don’t get lost. I need you to help me remember which animals belong to which zoo.” For each animal, the experimenter then asked the child, “Is this Y’s animal or Z’s animal?” Incorrect answers were corrected. After ownership had been established in this way, the animal cards were shuffled and laid out one at a time on the desk. For each card, the child was asked, “Does this animal belong in Y’s zoo or Z’s zoo? Put the animal back in the zoo it belongs in.”



Zoo boxes



Target animal cards



Example recognition selection

FIGURE 5.—Examples of Experiment 5 encoding and retrieval stimuli.

One week later, children met again with the experimenter and were verbally reminded of the first session and asked if they could recall any of the animals and, if so, who owned them. Children were then told that the animals had escaped and become mixed up with animals belonging to other people. To test for recognition of animals from the previous session, they were then shown one animal from the previous session together with three novel animals (placement of target on recognition card counterbalanced). The experimenter stated the types of animals on each card and asked, “I know we only played with one of these animals last time. Do you remember which one?” This procedure was repeated for all eight previously encountered animals, each time with a different set of distracters. To cue recall of ownership the child was then asked for each original animal, “Is that Y’s animal or Z’s animal?” As each child had the same amount of visual and motor exposure to all stimuli, animals were equally familiar; only the verbal-cognitive link specifying ownership differentiated them. Children were given general praise throughout but no specific feedback concerning accuracy; at the end of the session, they were given a sticker as a reward for participation.

### *Analysis*

One-sample *t* tests were used to determine if recognition memory and ownership assignments were above chance. Univariate ANOVAs were used to assess the impact of age and task type on ownership assignments at encoding and retrieval. A two-level (recall and recognition), two-factor (self-referent vs. other-referent) repeated-measures ANOVA with age group and task type as between-subjects factors was used to explore memory performance. To explore within-task SREs this analysis was also run separately for each task type (self-referent and other-referent). Within the other-referent control task, we originally intended to make comparisons between memory for stimuli owned by Mary and Billy. However, Experiment 1 alerts us to the possibility that this task could also be interpreted on a self-referent basis; that is, children could show a mnemonic bias for the actor who shared their gender. For this reason, this within-task analysis was also run on data entered as gender matched to the participant versus nongender matched.

### *Results*

#### *Encoding Ownership*

Correctly assigning ownership to an average of 6.8 (85%) animals ( $SD = 1.2$ ), children were above chance in assigning ownership in the first session,

$t(89) = 21.5, p < .001$ . Although both age groups were highly accurate, 4-year-olds ( $M = 6.9$  (86%),  $SD = 1.1, t(44) = 15, p < .001$ ) were consistently better at assigning ownership than 3-year-olds ( $M = 6.6$  (82%),  $SD = 1.3, t(44) = 15.4, p < .001$ ) ( $F(1, 86) = 6.5, p = .012, \eta_p^2 = 0.07$ ). Children were equally successful in encoding ownership in both task types (self-referent task:  $M = 6.9$  (86%),  $SD = 1.1, t(44) = 15, p < .001$ ; non-self-referent task:  $M = 6.6$  (82%),  $SD = 1.3, t(44) = 15.4, p < .001$ ).

### *Recall*

In the second session, 46 children (fifteen 3-year-olds and thirty-one 4-year-olds) offered free recall of animals presented in Session 1 ( $M = 2.7, SD = 1.6$ ). Age had a main effect on recall scores such that 4-year-olds outperformed 3-year-olds (3-year-olds:  $M = 0.5, SD = 0.2$ ; 4-year-olds:  $M = 2.2, SD = 0.3$ ;  $F(1, 86) = 27.8, p < .01, \eta_p^2 = 0.2$ ). However, there was no significant between-subjects effect of task type on the total number of animals recalled (self-referent task  $M = 1.6, SD = 0.3$ ; other-referent task  $M = 1.1, SD = 0.3$ ).

Within the self-referent task, children recalled significantly more of the animals owned by themselves ( $M = 0.9, SD = 1.2$ ) than those owned by the experimenter ( $M = 0.7, SD = 0.9$ ) ( $F(1, 43) = 4.2, p = .046, \eta_p^2 = 0.09$ ). Within the other-referent task, no significant bias emerged when comparing recall memory for Mary and Billy's animals (Mary  $M = 0.6, SD = 0.11$ , Billy  $M = 0.5, SD = 0.13$ ). However, reentry of the data on a "self-referent" versus "non-self-referent" basis showed that although not reaching significance, children tended to recall more animals owned by a same gender peer ( $M = 0.7, SD = 0.9$ ) than those owned by a different gender peer ( $M = 0.4, SD = 0.8$ ) ( $F(1, 43) = 3.2, p = .08, \eta_p^2 = 0.07$ ). There were no interactions with age.

Ownership assignments were accurate for an above-chance average of 84% ( $SD = 24%$ ) of recalled animals,  $t(45) = 9.5, p < .01$ . For children offering free recall, there was no evidence for an effect of age (3-year-olds  $M = 87%, SD = 6%, t(14) = 4.7, p < .01$ ; 4-year-olds  $M = 82%, SD = 4%, t(30) = 8.5, p < .01$ ) or task type (self-referent task  $M = 86%, SD = 5%, t(20) = 5.3, p < .01$ ; other-referent task  $M = 83%, SD = 5%, t(24) = 8.1, p < .01$ ) on the percentage of correct assignments.

### *Recognition*

As shown in Table 5, recognition performance was above chance for both tasks and age groups, for all encoding dimensions.

As for recall data, 4-year-olds consistently outperformed 3-year-olds in the recognition task,  $F(1, 86) = 14, p < .001, \eta_p^2 = 0.14$ . Here, task type had

TABLE 5  
EXPERIMENT 5 RECOGNITION PERFORMANCE SPLIT BY TASK, ENCODING DIMENSION,  
AND AGE GROUP

|                           |   |   |  |
|---------------------------|---|---|--|
| Unmatched<br>owned gender | $M = 2.8$ (70%),<br>$SD = 0.9$<br>$(t(44) = 9.9, p < .001)$ | $M = 2.7$ (67.5%),<br>$SD = 0.9$<br>$(t(22) = 9.1, p < .001)$ | $M = 3.1$ (77.5%),<br>$SD = 0.9$<br>$(t(21) = 11.3, p < .001)$ |
|---------------------------|---|---|--|

Note.—Thirty-seven children (thirteen 3-year-olds, twenty-four 4-year-olds; twenty-three self-referent, fourteen non-self-referent) performed at ceiling.

a marginally nonsignificant between-subjects effect,  $F(1, 86) = 3.4, p = .07, \eta_p^2 = 0.04$ , such that children tended to recognize more stimuli in the self-referent ownership task. However, there was no significant recognition bias for self-owned stimuli within the self-referent ownership task. Nor was any recognition bias evident within the other-referent control task (regardless of whether data were entered in order to make comparisons between recognition memory for Mary and Billy's items or for same gender-owned versus opposite gender-owned stimuli).

Children gave accurate ownership information for an above-chance average of 70% ( $SD = 23\%$ ) of the animals they recognized,  $t(89) = 7.9, p < .01$ . Analysis confirmed that 3-year-olds ( $M = 69.6\%, SD = 24\%, t(44) = 5.6, p < .01$ ) and 4-year-olds ( $M = 70\%, SD = 23\%, t(44) = 5.7, p < .01$ ) performed very similarly and success rates were similar for both task types (self-referent  $M = 73\%, SD = 24\%; t(44) = 4.6, p < .01$ ; other-referent  $M = 66.5\%, SD = 22\%; t(44) = 7, p < .01$ ).

### Discussion

Providing new empirical evidence that preschoolers can encode nonconditioned ownership information, Experiment 5 showed that children as young as 3 years were above chance in distinguishing recently experienced objects on the basis of ownership. Moreover, although 3-year-olds had a more limited capacity to acquire ownership information and to remember previously presented material, they were as adept as 4-year-olds in retrieving ownership information for stimuli they did remember after a delay. Importantly, retrieving accurate ownership information for the self required the children to make a retrospective cognitive link between the current self and owned material. The current self could not be implicitly associated with the stimuli, as children had the same physical experience of both self- and other-owned stimuli.

For the non-self-referent task, it is possible to argue that the cognitive link made between owners and animals is a form of paired-associate learning. In fact, the lack of any prior knowledge of the owners, and the visually accessible pairing of owners and stimuli, lends itself to such an interpretation. However,



not only were simple visual associations between stimuli and owners absent in the self-referent version of the task, the nature of personal pronouns means that children could not rely on word associations to encode ownership. Put simply, if children relied on the same paired associations verbalized by the experimenter in the self-referent task, their ownership information would be encoded wrongly. When the experimenter says “Yours - Lion,” children must encode “Mine - Lion” to succeed. Even if 3- and 4-year-old children were engaged in reflexive associative learning, for example, “Your (- My)–Lion,” “My (- Your)–Monkey,” their translation of yours to mine is a mystery without recourse to contextual self-other differentiation. Even adults, who process the personal relevance of pronouns automatically show activation of specific brain areas associated with other aspects of self-reflection when engaged in such a task (Esslen, Metzler, Pascual-Marqui, & Jancke, 2008; Walla, Duregger, Griener, Thurner, & Ehrenberger, 2008). For this reason, if the children were learning contextually translated word associates at encoding, they were doing so with the self in mind.

In support of a link between owned stimuli and the self-concept, there was some evidence of mnemonic bias for self-related stimuli. Children recalled more animals that they themselves owned than animals owned by the experimenter, despite experiencing them equally on a physical-cognitive level. Children also showed a nonsignificant owner-based advantage in the “non-self-referent” version of the task. Here, children tended to recall more animals that were owned by peers of the same gender as themselves than animals owned by peers of the opposite gender. As noted in Experiment 1, gender information is one of the first aspects of self-knowledge acquired. Moreover, in addition to an advantage for trait judgments concerning children’s families, Bennett and Sani (2008) found a marginal recall bias for judgments concerning children of the same gender (“Do you think boys/girls are . . . ?”) and of like-aged peers (“Do you think children of your age are . . . ?”). One explanation for Bennett and Sani’s (2008) findings, and our similar result, is that children are indexing a self-reference effect resulting from a judgments made of “someone like me,” where “me” activates the self-concept. This might explain why we did not find a significant between tasks advantage for self-referent task.

It is interesting that despite obtaining a similar level of recall as in Experiments 3 and 4, we find the first significant recall advantage in this cognitively (rather than perceptually) based test. One possibility is that recall SREs represent, or require, a greater depth of processing than recognition SREs. So, for example, although making an explicit visual link between self and stimuli at encoding might be sufficient to activate a recognition bias at retrieval (to jog memory), a cognitive link between self and stimuli might be required to give this information explicit priority. Another possibility is that such a distinction is traceable to encoding specificity. In paradigms where the link to self is

visual, tapping perceptually based memories is likely to elicit the strongest SRE.

## EXPERIMENT 6

Aside from the amount of information retained, Experiment 5 uncovered no differences in 3- and 4-year-olds' capacity to claim ownership of animals that were labeled as belonging to them 1 week before. Contrary to Povinelli et al. (1996) then, Experiment 6 indicates that young 3-year-olds can maintain a cognitive link between their past and present selves. Nevertheless, it remains possible that success in the delayed self-recognition (DSR) task might predict children's success in encoding ownership. To explore this possibility, Experiment 6 directly compares 3- to 4-year-old children's performance in Povinelli et al.'s (1996) DSR task with their ability to encode and retrieve stimuli with reference to ownership. If Povinelli et al.'s (1996) task does measure self-conservation, performance here might also predict the magnitude of any SRE found.

### *Method*

#### *Participants*

Thirty preschool children took part: fifteen 3-year-olds ( $M = 36.9$  months,  $SD = 2.2$  months, range = 34–42 months) and fifteen 4-year-olds ( $M = 47.9$  months,  $SD = 4.9$  months, range = 43–55 months).

#### *Materials*

The experimental stimuli for the self-referent ownership game were those used in Experiment 5. For the DSR task, a television, two video recorders, a pink "Post-it" sticker, three paper cups, and a small toy-shopping trolley were used.

#### *Procedure*

The procedure for the self-referent ownership task was described in Experiment 5; prior to this task, children were tested for DSR. The DSR test was adapted from Povinelli et al.'s (1996) procedure as follows. Upon entering the testing room, children were alerted to an activated video camera and asked

to wave to it. They were told the camera was recording so that “we can watch the game we are about to play on the television afterwards.” The child and experimenter then played a game in which a toy-shopping trolley was hidden under one of three cups while the child had their eyes shut. After the toy was hidden, the child was told to open their eyes and to lift the cups one at a time in order to find the toy. Children were given verbal and physical (brief pat on the head) praise every time they located the toy for a total of four trials. On the third trial, the experimenter used the head-pat to surreptitiously place a pink sticker on the hair just above the child’s forehead.

When the game was finished, the videotape was rewound to the point at which the child had waved. As the child was shown waving, the experimenter asked a self-recognition question: “Who is that?” The child was then encouraged to watch to see how well they played the game. After watching the marking event on video, corresponding to an approximately 3-min delay from the “real” marking event, the experimenter waited 30 s for a reaction before prompting: “What is that? . . . Is it a sticker? . . . Where is the sticker really? Can you get me it?” If the child did not react by reaching up for the sticker, they were given a hand mirror and the prompt repeated as appropriate. DSR was scored post hoc using video footage of the children’s reactions; children received 2 points for reaching for the mark before prompting, 1 point for reaching after prompting, and 0 points for failing to reach during the video playback.

### *Analysis*

Pearson’s correlations were used to explore the relationship between DSR performance and age, and between DSR performance and SREs. One-sample *t* tests were used to determine if recognition memory and ownership assignments were above chance. Univariate ANOVAs were used to assess the impact of age on ownership assignments at encoding and retrieval. A two-factor (self-owned vs. other-owned) repeated-measures ANOVA with age group as a between-subjects factor was used to explore recognition performance.

### *Results*

#### *DSR Task*

All fifteen 3.5- to 4-year-olds reached up to locate the sticker having viewed the marking event, six after being verbally prompted. Seven 3-year-olds also reached for the mark, three after verbal prompting. The remaining eight 3-year-olds did not reach up to locate the sticker until prompted by exposure

to the mirror. There was a positive correlation between age in months and delayed self-recognition score ( $r^2 = .46, p = .01$ ).

Of the 22 children who displayed mark-directed behavior, 17 responded “me” to the self-recognition question, 2 gave their proper name, and 3 gave no verbal response. Of the eight children who did not display mark-directed behavior, three responded “me,” two gave their proper name, and three gave no verbal response. The relationship between responses to the self-recognition question (2 points “me,” 1 point proper name, 0 points no verbal response) and performance in the delayed self-recognition test was not significant.

### *Encoding Ownership*

In the first session, children returned an above-chance average of 85% ( $M = 6.8, SD = 1.2$ ) of animals to the correct zoo,  $t(89) = 11.8, p < .01$ . Although both age groups were above chance (3-year-olds:  $M = 6.2, SD = 1.1, t(14) = 7.4, p < .01$ ; 4-year-olds:  $M = 7.4, SD = 1.2, t(14) = 11.1, p < .01$ ), as in Experiment 5, 4-year-olds outperformed 3-year-olds,  $F(1, 28) = 7.9, p = .009, \eta_p^2 = 0.2$ .

### *Recall*

In the second session, 11 children (five 3-year-olds and six 4-year-olds) offered free recall of animals presented in Session 1. These children remembered an average of 2.36 ( $SD = 0.8$ ) animals. Accurate ownership information was given for a mean of 72% of ( $SD = 28\%$ ) recalled animals. This level of ownership assignment was significantly above chance,  $t(10) = 2.5, p = .03$ . Although this low rate of recall precludes statistical analysis, of animals recalled 16 were self-owned and 11 were owned by the experimenter.

### *Recognition*

As shown in Table 6, the average number of animals recognized was significantly above chance; this result held overall, and for both age groups and encoding dimensions.

Age had no main effect on recognition scores. There was a large advantage for recognition of self-owned over other-owned stimuli,  $F(1, 28) = 7, p = .013, \eta_p^2 = 0.2$ , regardless of age.

Children gave accurate ownership information for an above-chance average of 73% ( $SD = 17\%$ ) of the animals recognized,  $t(29) = 7.3, p < .01$ . Both age groups were above chance (3-year-olds:  $M = 69\%, SD = 17\%, t(14) = 4.2$ ,

TABLE 6

EXPERIMENT 6 RECOGNITION PERFORMANCE, SPLIT BY ENCODING DIMENSION AND AGE GROUP

| Recognition | Overall  | Age Group   |   |
|-------------|--|---|---|
|             |  | 3-Year-Old  | 4-Year-Old  |
| Overall     | $M = 5.6$ (70%),<br>$SD = 1.8$<br>( $t(29) = 10.4, p < .001$ ) | $M = 5.4$ (67%),<br>$SD = 1.9$<br>( $t(29) = 6.6, p < .001$ ) | $M = 5.9$ (74%),<br>$SD = 1.7$<br>( $t(29) = 8.1, p < .001$ ) |
| Self-owned  | $M = 3$ (75%),<br>$SD = 1$<br>( $t(44) = 11.1, p < .001$ )     | $M = 2.7$ (67%),<br>$SD = 1$<br>( $t(14) = 6.9, p < .001$ )   | $M = 3.2$ (80%),<br>$SD = 1$<br>( $t(14) = 9.1, p < .001$ )   |
| Other-owned | $M = 2.6$ (65%),<br>$SD = 1$<br>( $t(44) = 8.9, p < .001$ )    | $M = 2.5$ (62%),<br>$SD = 1.1$<br>( $t(14) = 5.2, p < .001$ ) | $M = 2.7$ (67%),<br>$SD = 0.8$<br>( $t(14) = 7.5, p < .001$ ) |

Note.—Four children (two 3-year-olds, two 4-year-olds) performed at ceiling.

$p = .01$ ; 4-year-olds:  $M = 77\%$ ,  $SD = 16\%$ ,  $t(14) = 6.3, p < .01$ ), and analysis confirmed that age had no significant effect on ownership assignment.

*Comparison of Ownership and DSR Task*

Children who failed the self-recognition task performed similarly to those who passed in encoding and retrieving ownership information. As shown in Table 7 one-sample  $t$  tests confirmed that all DSR groups were above-chance level in assigning ownership.

Moreover, DSR and ownership performance did not correlate. Nor was there a correlation between DSR performance and the magnitude of difference in recognition between self-owned and other-owned stimuli, that is, the SRE.

TABLE 7

COMPARISON OF PERFORMANCE IN EXPERIMENT 6 SELF-REFERENT OWNERSHIP AND DELAYED SELF-RECOGNITION TASKS

| DSR Performance    | % Correct Ownership Assignments  |                                  |
|--------------------|----------------------------------|----------------------------------|
|                    | Session 1: Encoding              | Session 3: After Recognition     |
| No reaching        | 83%<br>( $t(7) = 7, p < .001$ )  | 71%<br>( $t(7) = 3, p = .01$ )   |
| Reach after prompt | 85%<br>( $t(9) = 6, p < .001$ )  | 73%<br>( $t(9) = 4, p = .03$ )   |
| Immediate reach    | 86%<br>( $t(11) = 7, p < .001$ ) | 75%<br>( $t(11) = 5, p < .001$ ) |

## *Discussion*

Performance in the DSR task closely replicated Povinelli et al.'s (1996) results; 60% of 4-year-olds but only 27% of 3-year-olds reached for the mark without prompting. A further 40% of 4-year-olds and 20% of younger children passed the task after verbal prompting. The remaining 3-year-olds successfully retrieved the sticker only upon being exposed to a mirror. As noted, Povinelli et al. (1996) interpreted younger children's failure on the DSR task as a failure to make a cognitive link between the past self, as represented in the video footage, and the present self. However, in Experiment 6, success on the DSR task was not associated with the ability to link the past self, as represented in a claim of ownership, with the present self. Children who failed the DSR task were as adept at assigning ownership as those who passed it. Moreover, in this sample, the magnitude of the now-significant recognition SRE was not related to DSR performance. In keeping with concerns regarding ceiling effects tested in Experiment 4, one reason that the recognition SRE might reach significance here but not in Experiment 5 is that fewer children (13% compared to 41%) performed at ceiling, leaving more scope to index an effect.

As noted in Chapter I, Skouteris et al. (2006) showed that using the video image to guide searches prior to DSR results in a greater proportion of 3-year-olds exhibiting mark-directed behavior. This raises the possibility that performance in the DSR might be related to ownership memory when difficulties interpreting video-based representations are controlled for. To test this hypothesis, training could be provided and 2-year-olds included in the sample to represent poor DSR performance. However, the likely benefit of video-guided searches is that they allow the child to learn that searching in the location on the video will bring success. This makes the extent to which trained children make reference to the self (other than as a location) doubtful. In support, 6 of 13 children in Skouteris et al.'s (2006) training conditions reached for the mark only after hearing the prompt "find me the sticker." For the remainder, who showed self-directed behavior immediately, the authors provide no information on ability to pass the DSR task prior to training. This makes it impossible to determine if they belonged to the subset of 3-year-olds who pass the DSR test naturally.

In any case, the dissociation between the ownership task and the DSR task can be explained in reference to the relative demands of each task. The DSR task requires making a link between self as represented internally, and the self as represented externally. Likewise, the ownership task requires maintenance of an internal link with an external object. However, only in the DSR task do past and current self-representations conflict, meaning that the children must revise a false belief ("I am not marked"). Younger preschoolers' difficulties in acknowledging false beliefs are well documented (see Mitchell, 1996;

Wellman, Cross, & Watson, 2001). This implies that the DSR task may be overly demanding for this age group, regardless of self-recognition or a video deficit. Interestingly, Saltmarsh and Mitchell (1999) showed that experience of video footage can actually support 3-year-olds in reporting memories that conflict with current knowledge. Three-year-olds asked to predict the contents of a familiar container (e.g., a candy tube) and then shown that the container holds unexpected contents (e.g., crayons) will typically deny their original prediction ("candy"), stating instead what they now know to be in the container ("crayons"). However, Saltmarsh and Mitchell (1999) found that when confronted with video footage of their original prediction, 3- to 4-year-olds were significantly (41%) more likely to acknowledge their past false belief.

The crucial difference between Saltmarsh and Mitchell's (1999) task and the DSR task is that the video footage makes salient what they child previously subjectively experienced; it does not require them to objectively reinterpret a past event. Although using time rather than representational change to separate past from present selves, the ownership task also supports children's memories of the self in the past through the provision of salient cues. In contrast to both of these tasks, the DSR task requires children to revise, rather than recover, a memory of the self in the past. Importantly, the demands of the ownership task appear particularly closely matched to those of autobiographical memory, requiring that children maintain a nonconflicting connection between past and present selves.

## EXPERIMENT 7

Experiments 5 and 6 focused on the link between ownership, self-conservation, and autobiographical processing. However, given that the ownership task relies on making an internal link between self and to-be-remembered stimuli, this paradigm may also offer the closest analog to the SRE established for adults. Just as trait adjectives are self-neutral before cognitive processing as self- or non-self-referent, the novel stimuli involved in the ownership task can only be considered self-referent postprocessing. As a result, we control for the contribution of self-focused attention to the effect. This is important, as rather than dictating what is encoded (as we hypothesize this might happen for an SRE driven by attention), the mnemonic bias for self-referent stimuli in the ownership task must be due to the type of processing it receives. Experiments 5 and 6 confirmed that children can make lasting representations of ownership even when stimuli are novel, similar, and experienced relatively briefly. The aim of Experiment 7 was to use a typical short delay SRE paradigm to confirm that this link is sufficient to support an immediate mnemonic advantage.

Although a significant ownership SRE is supported by Experiments 5 and 6, observation and elucidation of the effect was compromised by an apparently inadequate control task. This is important because the purpose of the between-subjects aspect of the design employed here was to allow independent observation of self- and other-referent processing. As noted, difficulty finding a non-self-referent control is relatively common. For example, in Bennett and Sani's (2008) study, when self (e.g., "Are you clever?") and non-self (e.g., "Are dogs clever?") processing was compared between children, many in the non-self condition began to talk about the family pet. Perhaps as a result, the SRE obtained was marginal. In fact, it has been repeatedly suggested that one of the reasons the self-concept is so elaborated (and mnemonically valuable) is that self-reference is our default encoding condition (Catrambone, Beike, & Niedenthal, 1996; Catrambone & Markus, 1987; Fong & Markus, 1982; Wells, Hoffman, & Enzel, 1984). Nevertheless, inclusion of an appropriate control is important as the only previously published test of the ownership SRE (Cunningham et al., 2008) conceived of the test solely as a within-subjects effect, offering no independent comparison with non-self-referent processing. For this reason, Experiment 7 adapts Cunningham et al.'s (2008) shopping paradigm for use with two groups of preschoolers: using ownership information to sort shopping items between baskets for one group and basket color as a sorting rule for another group.

## *Method*

### *Participants*

Fifty children took part: twenty-five 3-year-olds ( $M = 39.8$  months,  $SD = 1.3$  months, range = 37–42 months) and twenty-five 4-year-olds ( $M = 52.1$  months,  $SD = 4.2$  months, range = 43–58 months). Thirteen 3-year-olds and twelve 4-year-olds completed the self-referent ownership task; the remaining 25 children completed the non-self-referent control task.

### *Materials*

Three toy-shopping baskets were used (one green and two blue); in the self-referent version of the task, both baskets were blue, in the non-self-referent control, the two baskets were of different colors (one green and one blue).<sup>9</sup> At encoding, the experimental stimuli comprised 16 A6 photographic images of everyday food items (e.g., eggs, bread, bananas). At retrieval, 16 A4 recognition cards were introduced. Each recognition card showed one of the target shopping items together with two distracter animals that were





Target shopping items



Example recognition selection

FIGURE 6.—Examples of Experiment 7 encoding and retrieval stimuli.

not previously encountered. Pilot work confirmed that the items were easily recognizable to preschool children. Examples of these stimuli are shown in Figure 6.

*Procedure*

Under each condition, participants were encouraged to imagine that they were on a shopping trip with the experimenter to buy various food items.

On the table in front of them sat two baskets. In the ownership condition, children were told that one of the baskets was theirs and any items placed in their basket would belong to them, the other basket belonged to the experimenter. In the non-self-referent control, children were simply informed that the shopping would be shared between the green and blue baskets. In the ownership condition, the experimenter drew (at random) cards depicting different foods from the pack of 16 target cards and said, “Can you tell me what this is a picture of?” (e.g., *apple*) then (depending on whose turn it was to receive an item): “That is my/your \_\_\_\_ now! Can you put the \_\_\_\_\_ in my/your basket please?” This continued for all target items (eight per basket). In the control condition, once identified, items were allocated on the basis of color, that is, “Can you put that item in the green/blue basket, please?” After distribution of the target items, the experimenter placed both baskets out of sight. As described for Experiments 2, 3, and 4, children then played a brief distracter game, involving a marble being hidden beneath one of three cups.

Following the distracter game, to test free recall of previously encountered items, the experimenter said, “Do you remember we played a shopping game earlier? Do you remember any of the things we bought?” For each recalled item, the child was asked, “Who bought that? Was that mine or yours?” or “Which basket did that go in? Was that in the green basket or the blue basket?” To test for recognition of items from the previous session, they were then shown one target item together with two novel items (placement of target on recognition card counterbalanced). The experimenter named the items on the card and said, “I know we bought one of these things, can you remember which one?” As in they did earlier, children were then required to identify the source of recognized items (mine/yours/blue/green). Reference to personal pronouns and colors was counterbalanced throughout. As before, children were given a sticker at the end of the task to reward them for taking part.

### *Analysis*

One-sample *t* tests were used to determine if recognition memory and ownership assignments were above chance. Univariate ANOVAs were used to assess the impact of age and task type on ownership assignments at retrieval. A two-level (recall and recognition) two-factor (self-referent vs. other-referent) repeated-measures ANOVA with age group and task type as between-subjects factors was used to explore memory performance. To explore within-task SREs, this analysis was also run separately for each task type (self-referent and other-referent).

## Results

### Recall

Forty-five children (twenty-one 3-year-olds and twenty-four 4-year-olds) offered free recall of the shopping items ( $M = 4.5$ ,  $SD = 3.2$ ). Age had a main effect on recall scores,  $F(1, 46) = 18.1$ ,  $p < .01$ ,  $\eta_p^2 = 0.28$ , with 4-year-olds ( $M = 5.9$ ,  $SD = 0.6$ ) outperforming 3-year-olds ( $M = 2.3$ ,  $SD = 0.6$ ). However, there was no between-subjects effect of task type on the overall number of items recalled (ownership  $M = 2$ ,  $SD = 0.6$ ; control  $M = 2.1$ ,  $SD = 0.6$ ).

Within the ownership task, children recalled significantly more of the shopping items owned by themselves ( $M = 2.7$ ,  $SD = 0.2$ ) than those owned by the experimenter ( $M = 1.3$ ,  $SD = 1.7$ ) ( $F(1, 23) = 27.6$ ,  $p < .001$ ,  $\eta_p^2 = 0.5$ ). This SRE significantly interacted with age,  $F(1, 23) = 4.6$ ,  $p = .04$ ,  $\eta_p^2 = 0.17$ , such that 4-year-olds showed a larger bias (3-year-olds'  $M$  bias = 0.847; 4-year-olds'  $M$  bias = 2). Nevertheless, the SRE was significant for both age groups when analyzed separately (3-year-olds:  $F(1, 11) = 9.4$ ,  $p = .01$ ,  $\eta_p^2 = 0.46$ ; 4-year-olds:  $F(1, 12) = 19.5$ ,  $p = .001$ ,  $\eta_p^2 = 0.61$ ), despite the small sample size. By contrast, in the color-control task there was no significant recall bias (green  $M = 2.3$ ,  $SD = 0.4$ ; blue  $M = 1.9$ ,  $SD = 0.4$ ) or interaction with age.

Ownership assignments were accurate for an average of 72.2% ( $SD = 29\%$ ) of recalled items. A one-sample test confirmed this was significantly above chance,  $t(44) = 5.1$ ,  $p < .001$ . For the children offering free recall, there was no effect of age (3-year-olds:  $M = 71.9\%$ ,  $SD = 30\%$ ,  $t(20) = 3.3$ ,  $p = .004$ ; 4-year-olds:  $M = 72\%$ ,  $SD = 29\%$ ,  $t(23) = 3.8$ ,  $p = .001$ ) or task type (ownership  $M = 75\%$ ,  $SD = 26\%$ ,  $t(23) = 4.7$ ,  $p = .001$ ; control  $M = 69\%$ ,  $SD = 33\%$ ,  $t(20) = 2.6$ ,  $p = .001$ ) on the percentage of correct ownership scores obtained.

### Recognition

As shown in Table 8, recognition was above chance in both tasks and age groups and for all encoding dimensions.

As for recall, a univariate ANOVA with age and task type as a between-subjects variable indicated that age had a significant effect on recognition performance,  $F(1, 46) = 10.6$ ,  $p = .02$ ,  $\eta_p^2 = 0.19$ , with 4-year-olds outperforming 3-year-olds. Again, there was no significant between-subjects effect of task type,  $F(1, 46) = 0.7$ ,  $p = 0.39$ ,  $\eta_p^2 = 0.016$ .

Within the ownership task, children recognized marginally nonsignificantly more self- than other-owned stimuli,  $F(1, 23) = 3.6$ ,  $p = .069$ ,  $\eta_p^2 = 1.4$ ,

TABLE 8  
EXPERIMENT 7 RECOGNITION PERFORMANCE SPLIT BY TASK, ENCODING DIMENSION, AND AGE GROUP

| Recognition                      | Overall   | Age Group   |   |
|----------------------------------|---|---|---|
|                                  |   | 3-Year-Old  | 4-Year-Old  |
| Self-Referent Ownership Task     |   |   |   |
| Overall                          | $M = 13.4$ (84%),<br>$SD = 0.6$<br>$(t(24) = 11.8, p < .001)$ | $M = 12.1$ (76%),<br>$SD = 0.9$<br>$(t(11) = 6.5, p < .001)$  | $M = 14.7$ (92%),<br>$SD = 0.7$<br>$(t(12) = 11.9, p < .001)$ |
| Self-owned                       | $M = 7$ (87.5%),<br>$SD = 0.3$<br>$(t(24) = 12.4, p < .001)$  | $M = 6.3$ (79%),<br>$SD = 0.6$<br>$(t(11) = 5.8, p < .001)$   | $M = 7.6$ (95%),<br>$SD = 0.3$<br>$(t(12) = 17.3, p < .001)$  |
| Other-owned                      | $M = 6.3$ (79%),<br>$SD = 0.4$<br>$(t(24) = 8.4, p < .001)$   | $M = 5.6$ (70%),<br>$SD = 0.6$<br>$(t(11) = 4.5, p < .001)$   | $M = 7.1$ (89%),<br>$SD = 0.5$<br>$(t(12) = 8.1, p < .001)$   |
| Non-Self-Referent Ownership Task |   |   |   |
| Overall                          | $M = 12.5$ (78%),<br>$SD = 0.8$<br>$(t(24) = 8.1, p < .001)$  | $M = 10.8$ (67.5%),<br>$SD = 1.2$<br>$(t(12) = 4.1, p = .01)$ | $M = 14.3$ (89%),<br>$SD = 0.8$<br>$(t(11) = 10.1, p < .001)$ |
| Blue basket                      | $M = 6.1$ (76%),<br>$SD = 0.45$<br>$(t(24) = 6.8, p < .001)$  | $M = 5.2$ (65%),<br>$SD = 0.7$<br>$(t(12) = 3.2, p = .007)$   | $M = 7.1$ (89%),<br>$SD = 0.5$<br>$(t(11) = 8.7, p < .001)$   |
| Green basket                     | $M = 6.4$ (80%),<br>$SD = 0.4$<br>$(t(24) = 7.9, p < .001)$   | $M = 5.6$ (70%),<br>$SD = 0.7$<br>$(t(12) = 3.8, p = .002)$   | $M = 7.2$ (90%),<br>$SD = 0.4$<br>$(t(11) = 10.8, p < .001)$  |

Note.—Eighteen children performed at ceiling (five 3-year-olds, thirteen 4-year-olds).

whereas in the control task there was no suggestion of a recognition bias,  $F(1, 23) = 0.49$ ,  $p = .49$ ,  $\eta_p^2 = 0.021$ . There were no significant interactions with age.

Children gave accurate source-monitoring information for an above-chance average of 70% ( $SD = 19\%$ ) of items they recognized,  $t(49) = 7.1$ ,  $p < .01$ . As in Experiments 5 and 6, 3-year-olds ( $M = 68.4\%$ ,  $SD = 19\%$ ,  $t(24) = 4.8$ ,  $p < .01$ ) and 4-year-olds ( $M = 71.5\%$ ,  $SD = 21\%$ ,  $t(24) = 5.9$ ,  $p < .01$ ) performed comparably. Children also performed similarly in giving accurate ownership ( $M = 71.7\%$ ,  $SD = 24\%$ ;  $t(24) = 4.5$ ,  $p < .01$ ) and color location information ( $M = 68.2\%$ ,  $SD = 15\%$ ;  $t(24) = 6$ ,  $p < .01$ ).

### Discussion

Three- and four-year-old children recalled significantly more shopping items assigned to their basket than shopping items belonging to the experimenter, despite equal physical engagement with both types of item. Although

failing to reach significance (perhaps as ceiling effects were again common at 36%), the recognition data also followed this pattern. In contrast, children showed no recall or recognition bias when shopping items were assigned to baskets based on basket color. This confirms that the bias within the ownership data might be considered an SRE, providing novel evidence to support a cognitive SRE in children as young as 3.5 years and empirically substantiating the hypothesized link between ownership and the self. Moreover, these biases are evidently not due to increased engagement with the (arguably more interesting) ownership task. There was no significant difference in either the number of items remembered between assignment tasks or the number of items remembered with the correct source information (self vs. other and blue vs. green). In any case, this final test of the SRE confirms that for both 3- and 4-year-olds cognitive self-reference in the form of an ownership claim is sufficient to support a within-subjects recall advantage for self-referent stimuli. The aspects of cognitive self-recognition that support this SRE, and the other SREs reported in this volume, are open to discussion. In the final chapter, we discuss the implications, limitations, and applications of the current research.

#### NOTE

9. One constraint of Experiments 5 and 6 is that children may have relied on the color of zoos to distinguish between animals. No child made any explicit reference to zoo color in either session. Moreover, answering the ownership question correctly in the second session, when the zoos were absent, ultimately required that the child acknowledged the link between stimuli (animal or zoo) and owner. Nevertheless, we thought it wise to control for the effects of color in the self-referent version of this final study. As the results show, having zoos of the same color had no impact on the SRE. This confirms that color information (originally an accident of esthetics) was unlikely to have produced the SRE found in Experiments 5 and 6.

## **V. I REMEMBER ME: IMPLICATIONS, LIMITATIONS, AND APPLICATIONS**

In recognizing aspects of ourselves in the environment we make a cognitive connection between external and internal self-representation. Moreover, by virtue of connection to the self, material considered self-referent at encoding has priority at retrieval. As described earlier, this mnemonic advantage has been repeatedly demonstrated for adults (Englekamp, 1998; Symons & Johnson, 1997) and occasionally for school-age children (Baker-Ward et al., 1990; Bennett & Sani, 2008; Millward et al., 2000; Pullyblank et al., 1985; Sui & Zhu, 2005; Summers & Craik, 1994), but not for preschool children. However, the experiments reported in this volume provide original evidence to suggest that SREs, measured in a variety of ways, can be observed in the event memory of children as young as 3 years. This confirms that 3-year-olds' capacity to self-recognize has a functional impact beyond that previously measured in cognitive paradigms (such as the body-as-obstacle test and the mirror mark test of self-recognition). This final chapter offers discussion of the current findings with reference to the SRE literature and ends by relating this to the "bigger picture" of functional self-awareness.

### THE CURRENT FINDINGS

Experiment 1 indicated that even where self-reflection is proprioceptive (as in when we perform an action) or ambiguous (as when we match our gender or age group or name to some external stimulus), a mnemonic bias in recognition memory can occur. Experiment 2 indicated that personal identity has a strong pull in determining the focus of attention. When children were asked to remember objects that had been presented adjacent to an external self-representation of the self, 4-year-olds encountered some difficulty and 3-year-olds failed to recall the connection between self and object. Experiments 3 and 4 reversed this effect, demonstrating that when to-be-remembered objects were visually and verbally integrated with self- and other-photographs, short-term recognition memory for self-referent material was superior. Provided the memory task was sufficiently demanding, this

recognition bias was significant for both 3-year-olds (Experiment 3) and 4-year-olds (Experiment 4). Confirming that self-focus is at least sometimes the mediator of mnemonic self-bias, Experiments 3 and 4 also demonstrated that when faced with their reflection at encoding, children recognized relatively few objects that were associated with others by virtue of a second person pronoun (e.g., “He bounced the *ball*”). Finally, Experiments 5, 6, and 7 showed that preschool children can make active links between the self-system and otherwise neutral stimuli by encoding ownership information for novel objects. Moreover, as for the basic associations made between self and object in previous experiments, this abstract cognitive connection resulted in a mnemonic bias for self-referent (in this case self-owned) stimuli. Unlike previous experiments though, this SRE was most consistently shown in recall data.

We hypothesized that the magnitude of SRE, if reflecting the mnemonic “strength” of the self-concept, might be used to measure levels of self-awareness in preschool children. This would provide a nonbinary index of self-awareness that could differentiate between children (and therefore be correlated to other developments) beyond the 2nd year. In the event, as in previous studies with older children (Baker-Ward, Hess, and Flannigan, 1999; Bennett & Sani, 2008; Millward et al., 2000; Pullyblank et al., 1985; Sui & Zhu, 2005), we found little evidence for developmental progression in the magnitude of SREs. Three- and 4-year-olds returned significant SREs of similar magnitude whether the encoding task was kinesthetic, visual-cognitive, or built on an abstract cognitive link. However, several aspects of our results suggest that the use of the SRE paradigm to track developmental changes may not be as straightforward as anticipated.

For example, there are changes in memory capacity between the 3rd and 4th year (observable in all of the experiments reported) that have implications for the SRE. Specifically, as memory capacity approaches ceiling within a task, the potential for revealing an effect decreases. This means, as demonstrated in Experiment 4, that there is a need to calibrate task difficulty to age group. Unless one can manipulate the task such that memory performance is roughly equal, this precludes neat comparison of the magnitude of effects between age groups. Although one could enter total memory score as a covariate, the variance in the data predicted by this factor (the effect of memory capacity) is likely to be much larger than the variance predicted by the difference score between self and other (the effect of self-reference), meaning that the ability to show a main task effect would be substantially weakened. Given the strength of the relationship between age and memory capacity, the implications for an age interaction would be more serious still. One way to avoid this problem is to consider the change in any SRE not quantitatively but qualitatively; determining if the SRE found reaches significance for each age group when analyzed independently. However, our data suggest that this qualitative measure would divide children only for a limited period *prior* to the 3rd year. In other words,

without equal memory performance, the SRE paradigm cannot improve on mirror self-recognition as an index of developmental self-awareness.

There is also theoretical reason to question the capacity of the SRE paradigm to index developmental changes in self-awareness in the preschool years. Specifically, although we can confirm that self-referent events are tagged and given priority in preschool children's event memory, the mechanistic bases of the SREs reported are unclear. In addition to unique kinesthetic feedback, our data suggest at least two cognitive candidates to support self-bias in memory: an elaborated self-concept (superior encoding and retrieval for self) and self-focus (selective encoding for self). Importantly, only the former offers a clear prediction of developmental progression. The capacity to self-focus is binary, meaning that once it is acquired, we might expect little change in the magnitude of the resulting self-bias. By contrast, an SRE based on elaboration of the self-concept would be expected to increase as one's self-concept increases. This might explain why Sui and Zhu's (2005) visual SRE uncovered no increase in the magnitude of the SRE between 5 and 10 years and why our similar visual-cognitive paradigms (Experiments 2–4) found no evidence for developmental change between the 3rd and 4th year. In keeping with this explanation, the only significant age interaction was found in Experiment 7, where the self-referent nature of stimuli was fully internally mediated. It seems plausible that this paradigm would be less susceptible to the forces of selective attention than those in which stimuli are accompanied by an external representation of self (Experiments 1–4).

Whatever the reason for the lack of consistent age effects, their absence contributes to the debate regarding children's explicit reference to the self in the past. Contrary to Povinelli et al.'s (1996) suggestion of a lag in self-conservation between the 3rd and 4th year, we found no evidence to suggest that 3-year-olds have a self-specific retrieval failure. In Experiments 3–7, both 3- and 4-year-olds were above chance in monitoring whether remembered objects were encoded in self- or other-referent contexts. In other words, they made accurate reference to the self and other in the past. Moreover, this cognitive "tag" was accompanied by a significant SRE: Children recognized more objects associated with the self in the past than associated with other people. In the only case when source monitoring was below chance, for 3-year-olds in Experiment 2, the SRE was nonsignificant. This result implies that explicit self-recognition may be a necessary for self-bias to occur, and could be taken as support for Howe and colleagues' (Howe & Courage, 1993, 1997; Howe et al., 2003) proposal that explicit self-recognition is a requirement for autobiographically organized memories. However, do these self-referent memories fulfill the criteria for "autobiographical" recollection? Given that the children could both recognize stimuli, and accurately answer questions about the context of its encoding, it seems fair to suggest that they were experiencing something akin to episodic memory. Where the significant SRE



is found in recall data (as in Experiments 5 and 7), or the delay is long (as in Experiments 1, 5, and 6), the case is stronger still. Answering the source-monitoring question accurately required explicit reference to the role of self. If we accept that the memories refer to a specific episode in the past, and more particularly to the role of self (as distinguished from other) in this episode, we come close to the definition of autobiographical memory. This is particularly clear in cases where the self in the past referred to is not an external representation (as for self-image in Experiments 1–4) but an internal one (as in Experiments 5–7).

However, the distinction between remembering (when one recalls a specific episode) and knowing (when one stores information from the past) (Tulving, 2002) introduces a major caveat to this conclusion. The use of novel stimuli and the control of kinesthetic feedback in the current experiments ensured that children could not distinguish self- and other-referent memories on an associative level. Nevertheless, it is not clear that their memories contained experiential information of the sort that would be required to fulfill this stricter definition of autobiographical memory. In support of a developmental lag for experiential information, Perner and Ruffman (1995) provided evidence to suggest that children under the age of 4 years fail to acknowledge their own past experiences as a relevant factor in current knowledge. For example, when shown or told the hiding place of an object and shortly afterwards asked to retrieve it, 3-year-olds could find the object, but they could not state the source of their knowledge. However, although the answer required may appear simple (“I saw you hide it there”), the question “How do you know that?” is both conceptually complex and socially challenging. Recall, Saltmarsh and Mitchell (1999) corrected a similar result (denial of previous belief in the appearance/reality task) by supporting preschool children’s memories using video footage of their experience. Might a similar procedure be telling here? Certainly, it seems hasty to conclude that a 3-year-old’s failure to answer a question implies a lack of knowledge.

Considering the problem from another angle, it is not clear how one could distinguish between memory and knowledge in an age-appropriate way (other than controlling for associative learning). In studies with adults, this has been achieved by introspective self-report. Given Perner and Ruffman’s (1995) result, it appears that this would not be a fruitful approach for preschool children. Indeed, it is worth noting that the remember/know distinction has not proven intuitive. Adult participants have been found to struggle with it to the extent that it has been debated in the literature whether such a categorical distinction actually exists, or if it would be better to think in terms of a quantitative scale of the strength of the memory (Rotello, MacMillan, Reeder, & Wong, 2005). In fact, the latter method may well be applicable to a preschool sample. In the current research, it was not uncommon for children to refuse to select an item in recognition tests, implying that

they had meta-cognitive awareness of the strength (or weakness) of their memories. Perhaps future research might then consider children's subjective perceptions of accuracy in combination with objective measures as a proxy for remember/know distinctions. For example, we might consider "weakly" recognized stimuli with inaccurate (or below chance) source monitoring information to indicate knowledge, and the opposite pattern as indicative of a "true" episodic memory.

An issue separate to the extent to which specific self-referent memories might be considered autobiographical is the extent to which the existence of a memory bias is informative regarding the temporally extended self. In terms of building a life narrative, an SRE is positive regardless of the mechanism. A self-bias based on the organizational properties of the self-concept has the potential to inform our understanding of the memory structures underpinning the storage and retrieval of self-referent information. By contrast, an SRE based on selective attention has the potential to inform our understanding of how self-referent information is gathered in real time. It is likely that both processes, and indeed the kinesthetic feedback controlled for in the Experiments 2–7, contribute to a mature autobiographical memory system. The implications for self-conservation are more complex. A concept-based SRE might be taken to imply neurological self-conservation, leaving one to return to the debate concerning the extent to which explicit reference to the self in the past is made. However, if the SRE is attention based, self-recognition in the present (selective encoding) is all that is required for bias to occur.

Could this provide an alternative explanation for the lack of correlation between performance on Povinelli et al.'s (1996) DSR task and the magnitude of ownership SRE in Experiment 6? The between-subjects ownership SRE that would be expected if the effect was founded on the elaborative properties of the self-concept did not reach significance in Experiments 5 and 7. This might point to a mechanistic difference. An SRE based on self-focus would be expected to be expressed in a within-subjects test only. However, although a self-focus explanation fits the type of effect found, as set out earlier, it is not clear that this explanation fits the task. Contrary to Experiments 2–4, the stimuli here were initially self-neutral. Although it is conceivable that self-focus could have a post hoc effect, occurring after previously neutral stimuli has been judged self-referent, the subsequent removal of stimuli (to place in zoo or basket) means that any continued self-focus would have to be ruminative. Perhaps, then, the SRE was based not on the self-concept or "external" self-focus but on "sticky processing" of self-referent stimuli at encoding.

What the current research makes clear is that the elaborative or organizational nature of the self-concept is not the only plausible explanation for mnemonic self-bias, particularly given the different methods that have been employed. Moreover, it is vital that a variety of methods are employed if the SRE is to be considered anything other than a laboratory effect, unique to

the processing of trait descriptions. By measuring SREs based on motor self-recognition, visual self-recognition, and cognitive self-recognition, we start to build a picture of the “real world” potential of self-reference to inform cognitive processing. Moreover, we open new possibilities for mechanisms underlying the SRE. To illustrate, just prior to their innovative paper noting the potential for ownership judgments to index self-reference (Cunningham et al., 2008), Turk, Cunningham, and Macrae (2008) published a study noting that “incidental” self-referent processing (in this case stating whether stimuli was shown above or below one’s own name) is sufficient to produce an SRE.<sup>10</sup> This allowed them to argue against (or with) an elaborative processing account, for a more automatic augmentation of encoding, which they suggest might be based on capturing the participants attention (the self-focus explanation) or even their affect. The latter explanation is based on an established affective bias for self, such that self-reference is often associated with positive feelings. Turk et al. (2008) suggest that due to the positive emotional stimulation arising from self-reference, there may be increased activity in the amygdala and hippocampal areas, which in turn may enhance mnemonic processing.

Both attention and affective explanations could be applied to the “incidental” SREs found in Experiments 1–4. Moreover, as noted by Cunningham et al. (2008), as the positivity bias extends to self-referent objects, the affective mechanism potentially contributes to the ownership SREs found in Experiments 5–7. Research like this highlights that, despite the relatively long history of SRE literature, the effect is far from comprehensively understood. Further, unless we alter our perspective on the SRE paradigm (separating implicit from explicit processing, studying the ontogeny of the effect, using different forms of self-reference, etc.) this knowledge is likely to remain limited.

This is not to say that research using the original paradigm has run its course. Two particularly promising lines of enquiry involve application of the trait adjective paradigm to delineate the boundaries of self, neurologically and socially. In recent years researchers have begun to supplement behavioral SRE data with data from neuroimaging (see Northoff et al., 2006, for a meta-analysis). Several studies have demonstrated medial prefrontal cortical activation during the trait description SRE task (Craik et al., 1999; Johnson, Baxter et al., 2002; Kelley et al., 2002; Ray et al., 2009). Supporting the idea that this might be a center for “autobiographical” processing, some find that activity here is particularly prominent when the adjective is judged to be self-relevant, and the stimuli are later remembered (Fossati et al., 2003; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006). However, the medial prefrontal cortex is not the only area activated during self-processing. In keeping with (and extending) the affective explanation introduced above, researchers have found that judging adjectives self-relevant inevitably has some emotional consequence, the

valence of which is dependent on their desirability. This affective reaction is typically shown by activity in the ventral anterior cingulate cortex (Fossati et al., 2003; Moran et al., 2006) and may contribute to the memorable nature of self-referent stimuli. In addition to confirming that brain imaging techniques have the capacity to advance our understanding of the neural mechanisms underlying the SRE, this example supports our assertion that, to be fully understood, self-reflection should be considered both a subjective and objective process.

An alternative way to observe the boundaries of self, taking emotional attachment into account, is to vary the extent to which the processing task might be interpreted as self-referent. Although the original SRE paradigm used semantic processing as a control, an early paradigm shift was to contrast self-referent processing with processing of other people. Intended to allow assessment of the importance of familiarity to the SRE (and to provide a control with equivalent processing demands), researchers contrasted the self-processing task with a task in which the stimuli were judged relevant to a highly familiar person (such as the participant's mother). These studies showed that other-referent processing could lead to similar biases as self-referent processing, challenging the "special" nature of the effect (Bower & Gilligan, 1979; Kuiper & Rogers, 1979). However, Symons and Johnson's (1997) meta-analysis showed that rather than being a function of familiarity, biases in memory associated with person processing rely on intimacy with the target. Processing stimuli with a highly familiar celebrity in mind leads to less successful mnemonic retrieval than processing the stimuli with reference to a close relative, partner, or friend.

Aron and colleagues (Aron, Aron, & Norman 2001; Aron, Aron, Tudor, & Nelson, 1991) argued that the effect implies that intimate others are subsumed as part of the self-concept. Neuroimaging studies comparing self with intimate other have failed to consistently support or contradict this hypothesis (see Vanderwal, Hunyadi, Grupe, Connors, & Schultz, 2008, for review). Nevertheless, this debate is important as it highlights the potential for the SRE paradigm to expand our understanding of the concept of self, quite literally. Indeed, it would be interesting in the future to compare children's processing for self and others of varying degrees of intimacy. This could help to determine whether the growth of self-awareness is best conceived of as increased separation between self and other or, contrary to this traditional position, increased acceptance of other. As noted, both Baker-Ward et al. (1990) and Bennett and Sani (2008) had some success in demonstrating that at least by the age of 5 years, children remember a similar amount of information processed in reference to in-groups (family and peers) as processed in reference to themselves. However, implying developmental increases in separation of self and close other, Ray et al. (2009) found that although 7-year-olds

commonly remembered more trait adjectives processed in reference to their mother than to themselves, 13-year-olds showed the opposite pattern.

The SRE paradigm has also been applied to investigate the atypical boundaries of the self commonly found in autistic spectrum conditions (ASCs). Lombardo, Barnes, Wheelwright, and Baron-Cohen (2007) noted that although it was originally hypothesized that individuals with ASCs were shut off from others due to complete self-focus (e.g., Kanner, 1943), more recent theorists have proposed that ASCs might be characterized by an absence of self-focus (e.g., Frith, 2003). Absent, or in some cases reversed, SPT effects observed in children and adults with ASCs support this latter notion (Hare, Mellor, & Azmi, 2007; Millward et al., 2000; Russell & Jarrold, 1999). However, other researchers using similar methods have found the SPT effect to be intact in individuals with ASC (Lind & Bowler, 2009; Williams & Happe, 2009). The pattern of results for the SRE is also mixed. Whereas Toichi et al. (2002) reported that individuals with ASCs fail to show a mnemonic bias for trait adjectives judged self-referent, Lombardo et al. (2007) found an SRE which was reduced relative to controls, but significant. A fuller understanding of the mechanism(s) driving mnemonic self-bias has the potential not only to resolve these inconsistencies, but to facilitate our understanding of self-processing in ASCs. For example, Lombardo et al. (2007) found that their ASC group was impaired on four measures of empathy relative to controls. If this affective deficit also applies in situations where the self rather than other is the route of emotion (e.g., where self is required to be judged positively or negatively), it may be that the affective route to mnemonic self-bias is blocked for those with ASCs. If, as implied by the neurological data, cognitive and affective mechanisms work in tandem in the trait adjective paradigm, this would explain the reduced, but sometimes significant, effect.

The current research makes a valuable contribution to existing SRE literature by confirming that preschool children benefit mnemonically from various types of self-reference. In terms of ontogeny, we find that SREs have an early onset that globalizes to physical, visual, and cognitive channels of self-reference. Having established their presence, future research should aim to pinpoint the mechanism or mechanisms that underlie these effects. This is particularly important because different mechanisms have differing implications for the ontogeny of the effect in typically and nontypically developing populations. Evidently, investigation of the self-reference advantage in childhood will encounter challenges similar to, and over and above, those presented in research with adults. However, by carefully characterizing the types of effects found at different ages, we have the potential to tease apart the mnemonic impact of self-recognition as it first occurs. As outlined earlier, this process, or capacity, has clear parallels to both autobiographical memory and self-conservation. For this reason, the SRE paradigm may offer an accessible route to the study of these complex human phenomena in development.

## THE BIGGER PICTURE

The wider aim of the current research was to measure the functional impact of self-awareness. As noted in the introductory chapter, the only previously empirically demonstrated consequence of early self-awareness has been mark-directed behavior in the mirror self-recognition test. The experiments reported here demonstrate that cognitive self-recognition has more substantial consequences than prompting adjustments in self-presentation. Specifically, self-recognition appears to have an executive role in cognition, organizing attention, and mnemonic storage to give self-referent events mnemonic priority. Returning to the distinction made between the agentive “I” self and the descriptive “me” it seems that “I” is primed to gather information about, and remember, “me.” Not only do individual self-referent memories have survival value, but they also presumably play a formative role in our experience of personal identity as continuous. Without this continuity there would be no attachment to the self (cognitive or emotional) and therefore no motivation for self-preservation. This applies both at the basic level of survival and at the more complex level of morality (maintaining an “ideal” self). Importantly then, the SRE paradigm has the potential to index a cognitive-behavioral consequence of self-recognition congruent with the evolutionarily and developmentally powerful implications of self-awareness.

Moreover, consideration of the possible mechanisms driving SREs make clear that experience of the self is holistic. Previous developmental research has neglected the agentive self after self-recognition, behaving as though one nascent form of self-awareness (measured in preference tests) has been superseded by a more important form (indexed by the mirror test, linguistic self-reference, and self-conscious emotion). However, it is clear that the feeling of “owning” the self (subjective self-recognition) is equally important to the SRE as identifying properties of the self (objective self-recognition). This holds whether the SRE is based on association of material with an elaborated self-concept, on selective encoding of self-referent information, or on the emotional consequences of self-processing. In fact, the “special” nature of self-processing may hinge on agency. By virtue of having an elaborated concept of a familiar person I may show a mnemonic bias for information processed in relation to that person. If I have a high level of attachment to this familiar other, processing information relevant to them may also activate my self-concept or affect, lending superiority. However, it is not possible that I will gather the *same* amount of information about another person as myself (giving me an equivalently elaborated or defined concept of them) and feel the *same* level of attachment to them (allowing the same quality of elaboration and brain activation). This is simply because “I” am always with “me” and not always, or ever truly, with them. I am anchored to a different body and

mind, and to this solipsistic extent the self (and its mnemonic consequence) is special.

Using the SRE paradigm, it is possible to elucidate the processes leading to an idea of self in, and as an executor of, memory. As noted earlier, it is likely that the experience of self-continuity arising from these processes has far reaching affective and behavioral consequences. However, it should also be possible to directly measure the affective and behavioral consequences of the self. Several theories of the self as a “system” have been proposed; all agree that maintaining a consistent idea of self has a motivational impact on adults’ behavior (e.g., Bandura, 1986; Carver & Scheier, 1998; Duval & Silvia, 2001; Duval & Wicklund, 1972; Greenberg, Pyszczynski, & Solomon, 1986; Higgins, 1987; Leary & Baumeister, 2000). Each of these theories offers testable predictions that can be adapted for developmental research. However, despite considerable effort toward testing these predictions in adults, equivalent developmental tests remain almost nonexistent. As set out in the Introduction, this reflects a regrettable neglect of experimental measurement of the consequences of self-awareness in children.

To illustrate this point, consider the case of Duval and Wicklund’s (1972) objective self-awareness theory. Duval and Wicklund (1972) asserted that self-focused attention typically results in positive or negative affect, dependent on one’s perceived consistency with salient standards (e.g., the social desirability of a trait). As a result of the affective consequences of self-evaluation, people who judge themselves as inconsistent with the standard will be motivated either to adjust their to conform or to withdraw from the evaluation-inducing situation. In this way, cognitive and affective equilibrium regarding the self is maintained. According to this theory, any stimulus that reminds one of the self as an object (e.g., mirrors, audiences, cameras) will induce self-focused attention, followed by a cognitive and affective self-evaluative reaction, followed by a self-preserving action. Thus, objective self-awareness theory offers a testable theory of the complex relationship between self-recognition, cognition, affect, and behavior.

However, despite the inclusion of mirror self-recognition as a motivating variable, only a handful of studies have considered the ontogeny of these effects (Beaman, Klentz, Diener, & Svanum, 1979; Froming, Allen, & Jensen, 1985; Froming, Nasby, & McManus, 1998; Morin & Everett, 1991). Further, only one of these studies included preschool children. Beaman et al. (1979) recruited homeowners at Halloween to secretly observe the behavior of groups of trick-or-treaters who were left alone with a bowl of sweets with the instruction to take only one. The trick-or-treaters were between the ages of 1 and 13 years. In line with Duval and Wixklund’s (1972) theory, Beaman et al. (1979) found that children in the mirror condition were significantly more likely to follow their hosts’ instruction than children in the no-mirror condition. The magnitude of the mirror effect increased with age, remaining significant

for all but the youngest age group, consisting of 1- to 4-year-olds. However, consideration of 1- to 4-year-olds as a homogenous group may have compromised detection of an effect in older preschoolers. Considerable changes in self-awareness occur in this period, most notably the onset of mirror self-recognition.

To remedy this, we recently employed a similar temptation paradigm to assess the influence of self-recognition on a group of 3- and 4-year-olds' transgression of behavioral rules (Ross, Anderson, & Campbell, 2011). Inspired by a method pioneered by Lewis, Stanger, and Sullivan (1989), children were left alone in a room with a box that contained a toy and asked not to peek. As for the older children in Beaman et al.'s (1979) study, both 3- and 4-year-olds were more likely to adhere to the rule, and slower to break it, when the game was played in front of a large mirror than in conditions where the self was less salient. Although prosocial behavior has previously been correlated with the onset of mirror self-recognition (Bischof-Kohler, 1991; Johnson, 1982; Zahn-Waxler et al., 1992), this provides perhaps the first direct evidence that self-recognition plays a functional role in preschoolers' self-regulation. Moreover, it demonstrates that in addition to preschoolers' self-recognition potentially having a "cold" executive function in organizing memory, early self-recognition may have a "hot" executive function, namely the inhibition of socially unacceptable behavior. If we are to develop a comprehensive overview of the ontogenetic impact of self-recognition, it is important that both forms of regulation are explored.

Research of this type also has the potential to elucidate the phylogeny of self. As for children, the only established measure of self-awareness for nonhuman animals is the mirror mark test of self-recognition. The evidence for nonhuman primates indicates that only great apes pass this test, implying that the capacity for self-recognition is unique to the hominoid evolutionarily line. However, recently there have been controversial claims for mirror self-recognition in other animals, including dolphins (Reiss & Marino, 2001), elephants (Plotnick, de Waal, & Reiss, 2006), and magpies (Prior, Schwarz, & Güntürkün, 2008). The case for a unique hominoid capacity for self-recognition is therefore challenged not only by these claims but also by the mirror test's limited ecological validity. Given to the scarcity of reflective surfaces in nature, mirror-guided mark reaching cannot be the primary function of self-awareness. Indeed, the mirror mark test of self-recognition is designed to demonstrate a concept rather than qualify it. However, without qualification, we have no empirical basis to argue that the self-awareness of a magpie is any different than the self-awareness of a chimpanzee or an 18-month-old human.

One approach to this problem is to search for functional aspects of the human adult-like self in other animals. For example, it would be relatively easy to adapt the SPT paradigm for those animals whose memories and physical



dexterity are comparable to humans. This is important because, although we know that many animals experience agency (Mitchell, 2002), the cognitive consequences of this experience are unclear. Due to a lack of exposure to their own image, animals' representations of self are unlikely to center on their own facial features, precluding application of the visual-cognitive SREs measured in Experiments 2–5.<sup>11</sup> However, it may be possible to study mnemonic group-reference effects by pairing to-be-remembered stimuli with representations of familiar and unfamiliar conspecifics. Further, one could assess the impact of conspecific representations on socio-behavioral decisions, such as sharing food. Mnemonic or social group-reference effects might imply that the animal has a functional concept of “someone like me” from which we could extrapolate a functional concept of self. Finally, the concept of ownership has the potential to bring these strands of research together. Itakura (1992) demonstrated that one chimpanzee spontaneously associated her own green feeding bowl with herself, and two differently colored feeding bowls with two other apes. If this physical self-association were accompanied by an emotional attachment or a mnemonic bias (for novel stimuli placed in it), might this fulfill the criteria for a functional concept of “mine”?

This monograph explored one function of self-recognition in preschool children: External events are tagged as self-referent, rendering them memorable. Our results make clear that the mechanisms underlying this function require further study. In addition to stimulating research in this specific area, we aim to stimulate research on other functional consequences of self-recognition in children, adults, and nonhumans. Rather than discredit the mirror mark test as an index of self-awareness, a position that 40 years of research confirms would be untenable, we propose that this test should be supplemented with a qualification of what it means to self-recognize, cognitively, affectively, and behaviorally. Given that psychology is the study of the embodied self at a macrolevel, this topic is of consequence to almost every subdiscipline of the science. It is striking then that in certain areas, most notably developmental and comparative research, experimental exploration of the self has largely centered on one test.

## NOTES

10. It should be noted that although Experiments 1, 5, and 6 use similar methods to these studies, they were designed, completed, and interpreted prior to publication (or awareness) of Turk and colleagues' (2008) research. However, the design of Experiment 7 was directly based on the methods of this research team.

11. Although it *would* be interesting to see if, with repeated exposure, animals who pass the mirror mark test of self-recognition could discriminate their own features from those of conspecifics, and if so, would this self-recognition lead to social or mnemonic self-reference effects. Ultimately, it is also interesting to consider what effect not having a natural “tag” for the self-concept such as a face or a name might have for the experience of self-awareness.

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