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The Self: Elevated in Consciousness and Extended in Time

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In his now-classic text, *Play, Dreams, and Imitation in Children*, Jean Piaget (1962) described two incidents involving the reactions of his daughter, Jacqueline, to her own image. The first occurred when she had just turned 23 months old. "On coming in from a walk, J. said that she was going to see: *"Daddy, Odette and Jacqueline in the glass"* as if "Jacqueline in the glass" was someone other than herself (although she could recognize herself very well in a mirror)" (p. 224). The second incident occurred when Jacqueline was 35 months of age. Piaget had just shown her a photograph of herself. Jacqueline looked at the photo and stated: "It's Jacqueline." Intrigued by the third-person nature of her reply, Piaget asked her: "Is it you or not?" Jacqueline answered: "Yes it's me, but what has the Jacqueline in the photo got on her head?" (p. 225).

Some scholars may interpret these anecdotes as nothing more than mere curiosities involving a young child's reactions to the cultural artefacts of mirrors and photographs. In contrast, in this chapter I reinterpret Jacqueline's comments in light of recent research that has explored the child's developing understanding of the self's place in time. In doing so I hope to show how Jacqueline's comments may be emblematic of the unique manner in which very young children conceive of the self—a manner that does not include the idea that the self extends in time. I show how mirrors, video images, and photographs can be used as tools to reveal transitions in the development of an adult-like

understanding of the temporal breadth of the self. I propose that the development of an explicit and temporally extended self-concept can be understood as a developmentally complex process, tapping different conceptual and attentional structures at different ages.

THE SELF IN TIME

My original interests in the relation between time and the self-concept concerned chimpanzees, not human children. My curiosities about these matters were sparked many years ago after reading an article by Gordon G. Gallup, Jr. (1979), in which he had summarized his experiments showing that chimpanzees, but not most other primates, were capable of recognizing themselves in mirrors. To Gallup, this suggested that these apes might share with humans a kind of self-concept. He further speculated that if these animals had a concept of self, they might also be capable of projecting themselves into the past and future (see also Gallup, 1982). To me, the question seemed profound: Could chimpanzees conceive of their past and future, or was their notion of the self largely limited to the here and now?

However, as I mulled over the possible nature of the chimpanzee's self-concept, I began to appreciate the fact that we did not yet even understand at what age human infants and children develop the ability to conceive of the temporal dimensions of the self. One possibility, of course, was that young children's explicit awareness of their own past and future emerges in tandem with the very concept of self. Another possibility was that the temporal dimensions of the self are constructed gradually throughout late infancy and early childhood. However, there were no readily available experimental techniques that could address these questions.

Thus, I decided that before asking about another species' understanding of the temporal dimensions of the self it would be prudent to briefly shift my attention to our own species. However, what was intended as only a temporary methodological diversion has become a decade-long undertaking to explore how and when young children come to appreciate that they are more than just their own current set of experiences and sensations, that they are, in addition, historical beings—beings with a past, present, and future.

AN INITIAL IDEA—AND SOME INITIAL TESTS

My first thoughts on this matter were fairly naive: Perhaps the initial appearance of the self-concept was temporally restricted, perhaps extending for only a few minutes in time. From this starting point

children might progressively come to understand how more remote moments in time are connected to the present, ultimately allowing them to arrive at the point where, following William James (1890/1950), they conclude, "*I am the same self that I was yesterday*" (p. 332).

What empirical method could be used for tracking the transition of the self from its initial state of temporal restriction to its later, temporally extended state? At the time, the standard procedure for diagnosing the emergence of the self-concept was to assess the capacity for self-recognition in mirrors. The standard procedure involved wiping the child's nose or cheek with rouge and then placing him or her in front of a mirror to see if he or she would wipe it off (e.g., Amsterdam, 1972; Lewis & Brooks-Gunn, 1979). On the basis of these techniques, it was widely accepted that by about 18–24 months of age most infants were capable of recognizing themselves in mirrors. Thus, if my initial idea were correct, 2-year-olds ought to be capable of understanding how very recent former instances of the self related to the present self—but how could one empirically explore this idea?

One way of asking children about their ability to relate past instances of the self to their present state was to confront them with previous visual instances of themselves. What was needed was a variation of the classic mark test of self-recognition. However, instead of confronting the children with a live image of themselves, one would need to have them observe a video recording of an event which, unbeknownst to them, had happened just several minutes earlier—an event that had direct implications for their present appearance (e.g., an experimenter secretly placing a large sticker on top of their heads). All things being equal, would the children be able to infer the connection between the previous event and their probable current appearance? My colleagues and I conducted a set of preliminary experiments to explore these ideas (see Povinelli, Landau, & Perilloux, 1996).

Reactions to Delayed Video Images of the Self

In a first experiment, we individually videotaped 2-, 3-, and 4-year-old children and a familiar adult as they played an unusual game that they had never played before. During the game, the experimenter praised the child several times by patting him or her on the head. The experimenter used the final pat as the opportunity to place a large, brightly colored sticker on the child's head. Three minutes later, the child was shown a video recording that clearly depicted the previous events of (a) the child playing the game, (b) the experimenter placing the sticker on his or her head, and (c) several ensuing minutes of the child with the sticker on his or her head.

We had expected that even the youngest children ought to be able to relate what had happened just minutes earlier to their present state, and so the actual results startled us. None of the 2-year-olds, and only 25% of the 3-year-olds, ever reached up to their own heads to search for the sticker. They paid attention to the video, especially as it depicted the experimenter placing the sticker on their heads. Indeed, a number of these children remarked about this event. So why did they not reach up? Did they not recognize the image as themselves? In one sense, they clearly did. In the informal questioning that followed the test (which we systematized in later experiments), we asked many of the children "Who is that?" while pointing to their image on the video. The children had no difficulty in labeling their images properly (either by stating "That's me!" or by using their proper name). When we pointed to the image of the sticker and asked them (in a number of different ways) if they could get the sticker, they were simply unable to do so. It was as if they recognized the features of the image but did not grasp what it had to do with them.

In contrast, 75% of the 4-year-olds removed the sticker within seconds of seeing the pivotal marking event on videotape. Unlike most of their younger counterparts, the 4-year-old children seemed to have an immediate and intuitive grasp of the connection between the delayed video images and their present state.

Reactions to Recent Photos of the Self

Because of the surprising responses of the younger children in the test just described, we decided to explore the generality of our finding by examining 3- and 4-year-olds' reactions to recent Polaroid photographs of themselves. We chose this approach for several reasons. First, it was possible that the ongoing motion of the video events, rather then helping the younger children, may have actually confused them—causing them to objectify the images more than they would otherwise. Second, perhaps like adults, seeing themselves engaging in various behaviors on videotape elevated the children's levels of embarrassment, thereby inhibiting their willingness to remove the sticker from their heads. Third, although there was ample evidence of mirror self-recognition in young children, we sought to include a control condition in which the children who did not reach up in response to witnessing delayed images of the self were allowed to see themselves in a mirror. Fourth, we sought to incorporate a stronger temporal marker into the procedure to assist the children in localizing when the events had actually occurred. Fifth, we felt that the static photos might help us focus the children's attention on the key aspects of the events (the sticker on the head, the experimenter in the act of placing it there, and a key temporal marker that we introduced into the routine). Finally, we felt that the photos might assist us in using

a standardized (and somewhat leading) set of questions that might assist the younger children in making the connection between the image and themselves.

This study proceeded in much the same manner as the first one (playing an unusual game, secretly placing a large sticker on the child's head, etc.). However, instead of videotaping the children, we took two Polaroid snapshots of them at two critical junctures in the procedure. The first photo was taken just as the experimenter was praising the child and placing the sticker on his or her head. This procedure was carefully choreographed so that the photo clearly depicted the child's upper torso and head and the experimenter's hand putting the sticker in place. The second photo was taken at the end of the game. One of the experimenters introduced the child to a large stuffed gorilla that the child had never seen before and explained to the child that the other experimenter was going to take another picture—this time of the gorilla, the experimenter, and the child (with the sticker still on his or her head).

Approximately 2–3 minutes later, the main experimenter let the child look at the two photos, one at a time. For each photograph, the child was allowed to look at it and was then asked: "Who is that?", "What is that?" (as the sticker was pointed out), and then, "Where is that sticker right now?" In addition, for the first photograph, which depicted one of the experimenters in the act of placing the sticker on the child's head, the child was asked, "What's [the experimenter's name] doing right there?" Finally, the children who still did not reach up to their own heads were presented with a large mirror.

The results were consistent with those of our first experiment (see Fig. 5.1a). First, only 13% of the young 3-year-olds (35–42 months) reached up for the sticker (even after the verbal prompting). In contrast, 85% of the young 3-year-olds who did not reach up in response to the photos did reach up when they were allowed to see themselves in the mirror. Second, the results depicted in Fig. 5.1a show a clear developmental trend between 3 and 4 years in children's ability to use the delayed information to infer the location of the sticker of their heads.

Equally intriguing were the children's responses to our questions. First, even the group of young 3-year-olds had little difficulty when they were asked, "Who is that?": Eighty percent of them answered correctly by either saying, "me," their proper name, or pointing to themselves. The older children performed at even higher levels (see Fig. 5.1b). However, the 3-year-olds tended to use their proper name as much or more than the personal pronoun *me*, whereas the older children almost never used their proper names. Second, when asked "What is that?" (while the sticker in the photo was pointed out to them), the youngest children had little difficulty in identifying it correctly—again, 80% of them responded correctly (see Fig. 5.1c). In combination, these results revealed that, in

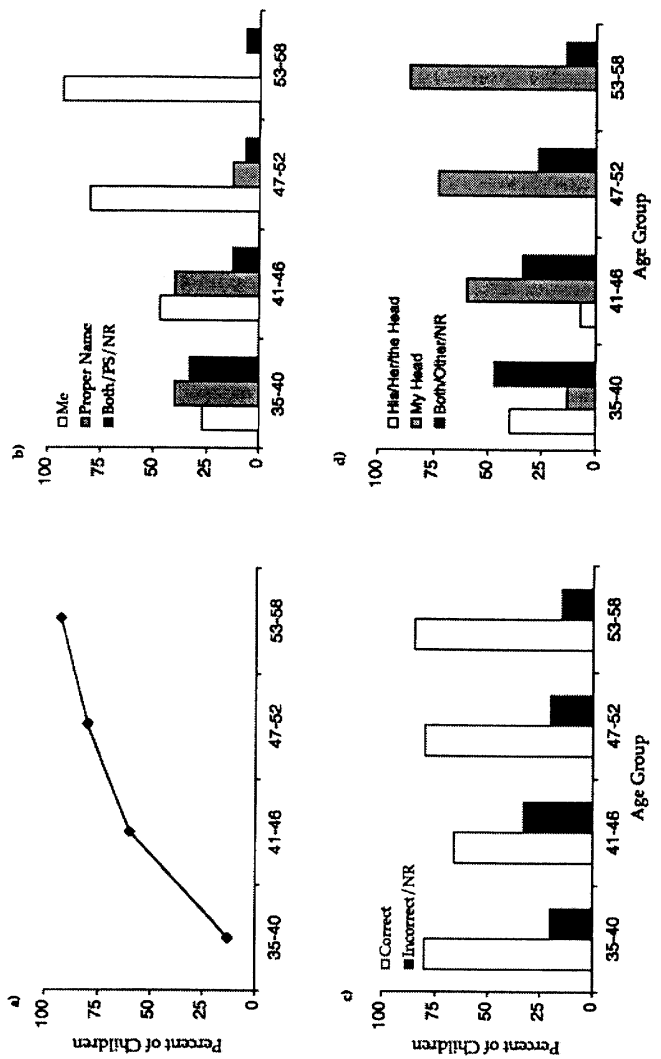

Fig. 5.1. Children's reactions to photographs of the self that revealed that a sticker had been covertly placed on their heads. Panel a: percentage of children who searched for the sticker. Panel b: percentage of children who used 'me' vs. their proper name to label the photograph. Panel c: percentage of children who correctly identified the sticker. Panel d: percentage of children who used first vs. third-person descriptions of the image. Note: PS = point to self; NR = no response.

some sense at least, the 3-year-olds both recognized themselves in the photos and noticed the sticker on the head of the image in the picture. Apparently, there were some other reasons why the younger children did not seem to understand that there was a sticker on their heads at that very moment.

Finally, the children's answers to the final question were classified according to whether their answer used the expression "my head" (e.g., "He's putting the sticker on my head") or whether they used a phrase that dissociated themselves from the image such as "his/her/the head" (e.g., "He's putting the sticker on her head"). The results of this analysis are depicted in Fig. 5.1d. The youngest children preferred to use the dissociative phrases, the opposite pattern displayed by the older children. Indeed, there was a significant correlation between whether the children reached up for the sticker on their heads and the nature of the phrase they used. The group of children who did not reach up used both phrases equally often. In contrast, only a single child who reached up for the sticker used one of these dissociative phrases.

Although I have summarized the statistical evidence that the children who seemed unable to infer that they had a sticker on their head tended to provide verbal descriptions that distanced themselves from the images (e.g., using their proper name, or talking about the sticker as if it were on someone else's head), these statistical summaries do not completely capture how odd some of the younger children's answers seemed. For example, in response to our questions, one 3-year-old responded, "it's Jennifer" and "it's a sticker" and then added, "but why is she wearing my shirt?"

Reactions to Delayed Versus Live Video Images of the Self

The previous studies provide some surprising evidence that 2- and 3-year-old children may not understand the connection between recent past events and their current physical state. This suggested a dissociation between their reactions to live versus delayed visual feedback of the self. However, we had not yet conducted a test in which separate groups of children were tested under conditions in which the only parameter that differed was whether they saw themselves in live versus delayed video. So, in a third initial study we repeated the video test with two groups of 2- to 3-year-old children. After the sticker was covertly placed on their heads, one group was shown live video feedback, whereas the other group was shown delayed feedback from about 3 minutes earlier.

The results were in the direction predicted: Sixty-two percent of the children who saw themselves in live feedback reached up, whereas only 37% in the delayed group did so. Although this effect was only marginally significant, there was a significant difference in the timing of

when the successful children in the two groups reached up. In the live group, 71% of the successful children reached up during the 2-minute presentation of their images, whereas the remainder reached up at some point during the prompting/questioning period. This pattern was reversed in the delayed group, in which only 22% of the successful children reached up during the video presentation.

These results suggest that the temporal dimension of the playback, by itself, may be a crucial factor in the developmental pattern obtained in the first two studies we conducted. For some reason, when the images are delayed, young children seem less able to grasp the connection between the images and themselves. We realized that we needed a more formal framework in which we could think about this difference, as well as the developmental pattern we had obtained.

A MODEL OF YOUNG CHILDREN'S UNDERSTANDING OF THE TEMPORAL DIMENSIONS OF THE SELF

The purpose of our model was threefold (see Povinelli, 1995). First, we sought to develop an account of a possible transition from the representation of the self as an on-line, experiencing agent, to a representation that explicitly includes the connection among the present, past, and future states of the self. Second, we sought a more integrated account of the psychological processes that initially allow 18- to 24-month-old human infants (and chimpanzees) to recognize themselves in mirrors. Finally, we sought an explanation for why it is not until about 4 years of age that children pass the analogous test using delayed feedback.

The Present Self

The model begins with an assumption that at around 18 to 24 months of age most infants develop an explicit self-concept—an ability for various dimensions of the self to be held in consciousness as objects of thought. This development is seen as a more or less direct consequence of other, domain-general cognitive developments that emerge during this same period. Furthermore, these domain-general abilities are seen as allowing infants to form explicit relations between objects and events in the world, on the one hand, and their representation of various aspects of the self, on the other. A number of specific proposals for cognitive development during this time period are compatible with this view (e.g., Case, 1992; Olson & Campbell, 1993; Perner, 1991). Our model (Povinelli, 1995) posits that these changes allow certain kinds of information about the self that were previously implicitly available, to become consolidated

into a conceptual structure. In this way the self can become an explicit object of thought and thus related to events out in the world (see Povinelli, 1995).

Which specific aspects of the self become explicitly represented at this age? The model supposes that, in human infants, the initial self-concept includes the infant's representation of both his or her current kinesthetic and mental states. For reasons to which I briefly allude later, the model supposes that the kinesthetic information is the most salient and omnipresent for the infants. Of course, because of the rapidly changing nature of the infant's postural states and actions, this kinesthetic representation is likely to be constantly updated and hence largely restricted to the present sensory input. Following James (1890/1950), I have referred to this representation as the *present self.*

What about information about previous states of the self—is this information included as part of the 2- to 3-year-olds' self-concept? On the one hand, one might be tempted to say yes, given that the model allows that children of this age store information about past events, including past states of the self. However, the model also stipulates that these memories are not conceptualized as experiences that a former instance of the present self underwent. Indeed, somewhat radically, the model stipulates that even memories of quite recent events—events that the 2- to 3-year-old child can verbally recall—are not explicitly represented as temporal trailings of their present self. The reason is because our model supposes that the general difficulty that 2- to 3-year-olds have in understanding how one object or event can have multiple natures (e.g., Flavell, 1988), applies with equal force to their understanding of the self. And, as I explain later, this may have some fairly striking implications for the temporal breadth of the 2- to 3-year-old's present self.

By focusing on the kinesthetic dimension of the self, the model provides a fairly specific account of the process by which 18- to 24-month-olds come to react to the mark test by reaching up to their own faces. In doing so, the model shares certain features with previous accounts of mirror self-recognition (see Gallup, 1970; Mitchell, 1993). However, it begins with a novel and seemingly counterintuitive idea: namely, that the ability to pass the mark test has nothing to do with understanding what mirrors do (i.e., understanding that mirrors provide an accurate and contingent image of things that are in front of them).

But if infants do not understand that mirrors provide a reflection of themselves, how is self-recognition possible? I propose that the first step in answering this question is to set aside the term *self-recognition* altogether and to instead speak of various *equivalence relations* that infants may or may not form between their representations of themselves and the images of the self that they confront in mirrors. The necessity of invoking the idea of equivalence relations stems from the realization that the term *self-recognition* is not fine grained enough to

develop a proper theory of the multiple dimensions along which infants may explicitly map the relation between their physical and mental states and their images in mirrors.

The model posits that infants detect an equivalence between their explicit representation of their bodies (their kinesthetic states) and the actions of the images in the live feedback before them. If the infant possessed the domain-general ability just described (the ability to form a relation between a concept held in mind and external objects and events), then the infant could form the following sort of relation between its kinesthetic state and the image in the mirror: "Everything that is true of this (my body here) is also true of that (the image), and vice versa." Presumably, the formation of this relation may occur quite rapidly, as infants in preindustrialized cultures with little or no access to mirrors may pass the mark test with as little as 5 minutes of experience with a mirror (see Priel & de Schonen, 1986).

In summary, the causal account of the factors that lead 18- to 24-month-old infants to reach up and touch marks on their faces is that they conclude that there is an equivalence between the bodily self (held in mind) and the stimuli they confront out there (the image in the mirror), not that they realize that the image is a representation of themselves.

One of the most important aspects of this account of self-recognition is that it explicitly models the impact of the separate dimensions along which infants may detect an equivalence relation between their representations of the self and the images they confront. Two of these dimensions are seen to be especially important in making sense of the patterns of the children's responses: (a) the infants' detection of the equivalence between their representation of their physical features and the physical features portrayed in the images and (b) the infants' detection of the equivalence between their representation of their kinesthetic states and the movements of the images.

For several reasons, I suspect that the most important and earliest emerging dimension is the kinesthetic one. First, unlike the features of one's face (and the rest of the body), one's kinesthetic state can be constantly experienced and does not depend on looking at the body, let alone confronting oneself in a mirror. In addition, the evolutionary emergence of the first nonhuman primate with an explicit self-representation may have been associated with the evolution of the common ancestor of the great apes and humans and may have been driven by the need to represent and integrate the self's kinesthetic states (see Povinelli & Cant, 1995). This evolutionary model argues that an unprecedented increase in body size for an arboreal mammal that occurred in the common ancestor of the great apes and humans, created a specific set of ecological problems, the solution to which involved integrating various low-level streams of proprioceptive and kinesthetic information into an explicit representation of the self's bodily position

and movements. I suspect that this evolutionarily primitive self-concept—a kinesthetic self-concept—remains the most salient dimension of the self early in human development.

Returning to the developmental emergence of the ability to pass the mark test, this model holds that once the equivalence relation between one's own actions and the actions of the image are formed, other equivalences may soon be explicitly represented as well—for example, between the appearance of aspects of the body that are directly visible and the image of the body in the mirror and, ultimately, the otherwise-invisible aspects of the body, such as the face (see Povinelli, 1995, for a detailed account of this process).[1]

Although the question of self-recognition in mirrors has often been cast as a problem of how the infant comes to know that the face he or she sees in the mirror is his or her own face (e.g., Mitchell, 1993), this model would view this as a false issue. Once the infant has formed an explicit representation of the self that includes its kinesthetic states and those featural aspects of the body that are directly observable, updating the representation while confronting a mirror becomes straightforward. After all, once the infant concludes that there is an equivalence between their kinesthetic and partial featural self-representation on the one hand, and the image on the other, then the mirror simply allows him or her to update the (incomplete) featural self-representation.

Do Children "Recognize" Themselves in Delayed Videos and Photos?

Assuming that this model is roughly correct, let us move on and consider what must occur when 2- or 3-year-olds confront their images in delayed versus live visual feedback. If, as I have speculated, the kinesthetic dimension of the self is the most salient aspect of the self that is explicitly represented, then when these children confront themselves in live feedback they will detect a perfect match between their kinesthetic self-representation and the movements in the mirror. The child therefore concludes, "That is equivalent to me." In contrast, when the image is

[1]This account raises the question of whether infants reach up for the mark because it violates a schema they have of their face, or simply because the mark is of some intrinsic interest. Our model suggests different answers at different points in development. If one were to take a 24-month-old infant who had not yet mapped out his or her facial features through experience with mirrors, mark his or her face, and then confront him or her with a mirror, we suspect that the infant's intrinsic interest in the mark would drive the reaching response. On the other hand, an additional factor is likely to be involved in the reaching response of the 24-month-old who already possesses a default scheme of what his or her face looks like—for this infant, the mark "shouldn't be there."

delayed, this equivalence is not present, and the infant concludes, "That is not equivalent to me." In the former case, the mark is noted by the child, and his or her relation to his or her own body understood; in the latter case, however, although the mark may be noted it bears no explicit relation to the child's body.

A further complication arises, however, because, depending on his or her prior history with mirrors, the 2-year-old child may have already formed a self-representation that includes information about his or her facial features (through the process described earlier). Thus, if the very young child focuses his or her attention on the facial and general bodily features of the image, an equivalence relation may be formed in either live or delayed situations. After all, the featural appearance of the self is, for all practical purposes, invariant across fairly long temporal intervals. Thus, depending on how any given 2- or 3-year-old child partitions his or her attention to the various aspects of the self, he or she may confront seemingly contradictory, or rapidly alternating, information concerning whether the image is equivalent to him- or herself: the kinesthetic information says 'no," but the featural information says "yes."

Indeed, this would seem to be exactly the kind of dual interpretation of their images that 2- and 3-year-olds seem to express as they observe their delayed images. On the one hand, they seem to understand the name of the image, but on the other hand they seem to distance themselves from the image. Furthermore, because the kinesthetic information is the most salient aspect of the current self-representation, most children of this age conclude that the image is not equivalent to themselves. However, a smaller percentage of the children may background the kinesthetic information, allowing them to focus on the featural information for long enough to conclude (at least temporarily) that there is an equivalence. In the former case, they would not reach for the sticker; in the latter case, they would.

These considerations led us to speculate (e.g., Povinelli, 1995), that the temporal dimension of 2- to 3-year-olds' representations of the present self might be very narrow indeed—perhaps on the order of 1–2 seconds. Some authors have found this idea inherently suspect, arguing that our model implies that 3-year-olds cannot conceive of themselves beyond several seconds in the past or future (e.g., Zelazo & Sommerville, chap. 12, this volume). However, what the model actually stipulates is 2- to 3-year-olds' inability to integrate successive present selves along a purported temporal–causal dimension, not their inability to store or imagine past or future states of the self (Povinelli, 1995, p. 167). Thus, the possible temporal restriction of 2- to 3-year-olds' current self-representations in no way necessitates the absence of a memory of past self states or the inability to imagine future ones. They have simply not yet adopted an ontology in which those states can be placed within a temporal–causal continuum. By implication, they have no way to relate

their current self to such future or past states (for a discussion of the possible ways in which 3-year-olds may conceive of the past, present, and future, see Povinelli, Landry, Theall, Clark, & Castille, 1999). Indeed, on our account, certain future-oriented behaviors (especially those that are highly routinized, script-like, or are based on procedural rules) should prove quite simple for 2- to 3-year-olds, whereas other behaviors, which require an explicit understanding of the relation between the child's present self and some imagined future state, ought to prove far more difficult (see Atance & O'Neill, chap. 7, this volume).

The Proper (or Temporally Extended) Self

What about older children? When and how do they develop a representation of self that extends in time? This model highlights the importance of a second domain-general cognitive transition that may occur at around 4–5 years of age—a transition that may have the consequence of allowing the child to hold in mind multiple representations of the self (past, present, and future states) as all referring to the same entity: the self. I have labeled this the *proper self* after the proper names that we typically use to embrace all the present, past, and future states of the self. Thus, with the emergence of the proper self the present self becomes simply the most salient of the multiple instances of the self that extend forward and backward in time. Some theorists who have argued for a strong domain-general developmental transition in conceptual abilities at around 18–24 months have also argued for another domain-general transition at around 4–5 years of age (see Case, 1992; Olson & Campbell, 1993; Perner, 1991). In these and certain other theories, the child is seen as becoming capable of sustaining multiple, and contradictory representations of the same object or event. This model posits that this general ability applies to the child's self-representation as well. Thus, this domain-general ability paves the way for the child to sustain not simply one current representation of the self but also to organize previous, current, and future representations under a temporally extended, metaconcept of "me."

RECENT DIRECTIONS

With this framework in place, my colleagues and I have sought to probe additional aspects of the child's developing awareness of the self's place in time. In what follows I briefly mention several of these recent studies.

Extending the Self in Time: Brief Versus Extreme Delay

Earlier in this chapter, I argued that younger preschoolers experience a dual interpretation of their delayed images. On the one hand, the featural information leads them to detect an equivalence between themselves and the image; on the other hand, the kinesthetic information suggests a nonequivalence. Thus, a certain percentage of young preschoolers reach up for the sticker on their head, but for different reasons than the majority of the older preschoolers. This raises a sticky problem. We are suggesting that the exact same behavioral response (reaching up to the head to remove the sticker) may have different psychological causes at different ages. Is there any way to demonstrate this empirically? In other words, is there any way to show that 3-year-olds who pass the test do so on the basis of featural cues, whereas older children pass the test on the basis of inferences derived from a representation of the self that is temporally extended?

It occurred to us that if our general model were correct, then older preschoolers ought to appreciate that, other things being equal, very recent events have more causal bearing on the present than do more distant events. Younger children, in contrast, should fail to appreciate such a distinction, either because they do not conceive of previous events as "previous" at all or simply because to them time is not seen as a causal arrow.

Our first test of this idea was reported by Povinelli and Simon (1998), who invited 88 young 3-, 4-, and 5-year-olds (32 children in each age group) to two visits to our laboratory. Each visit was separated by 7 days. On the first visit the children played a distinctive game in a particular room. As usual, we secretly marked them with a large sticker while a video camera recorded the events and the game. However, just as the children were finishing, rather then showing them the video, we secretly removed the sticker from their heads. Thus, although they left the center none the wiser, we had obtained a video of them playing a distinctive game and being marked on their head with a sticker.

A week later, the children were invited to play a different game in a different room at the center, and we again covertly placed a sticker on their heads. Now, however, we allowed the children to witness themselves on videotape. The critical manipulation was that in each age group, half of the children (N = 16) observed the recording from 5 minutes earlier, whereas the other half observed the recording from the week before.

The results for the presentation period of this study are depicted in Fig. 5.2. As predicted, the older children understood the distinction between the two tapes. Very few of the 4- and 5-year-olds who were

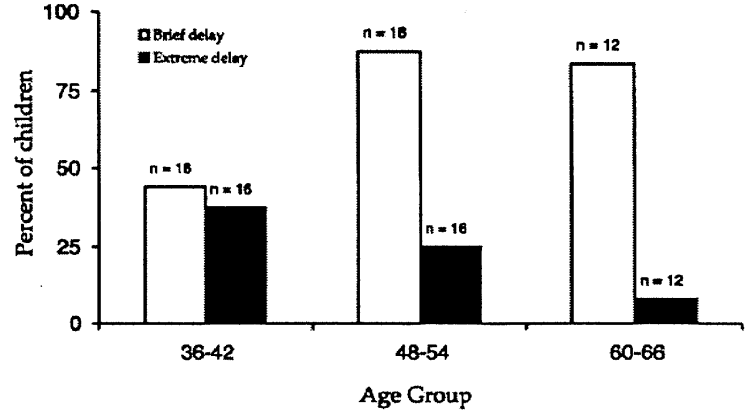

FIG. 5.2. Percentage of children who reached up to search for a sticker on their head in response to briefly versus extremely delayed images of themselves.

confronted with images of themselves from the previous week reached up to search for the sticker—exactly as if they appreciated that the events that they were seeing had no direct relevance to their current appearance. In contrast, the majority of the 4- and 5-year-olds who observed the events from just a few minutes earlier reached up for the sticker. This logic of the experimental design allows us to conclude that the factor responsible for this difference is *when* the images were recorded. One more particular interpretation is that the older children appreciated the causal structure of time and their current place within this structure.

The 3-year-olds showed a very different pattern of results—again, consistent with the predictions of the model. Almost the same percentage of children reached up in both the briefly and extremely delayed groups (see Fig. 5.2), and this percentage was roughly comparable to the levels obtained in previous studies in this age group. In other words, although some of the 3-year-olds did reach up for the sticker, there was no evidence that they did so because they appreciated the temporal–causal significance of the events that they were observing. Rather, this result provided support for the idea that the same measure (reaching up to the head for the sticker) is triggered by different psychological processes in young versus older preschoolers. Most 3-years-olds conclude from the kinesthetic information that the images are not equivalent to themselves, although a certain percentage may reach up because they detect the featural equivalence between the image and their representation of their appearance. However, because this featural

information is more or less constant across the time intervals examined, they do not understand the crucial difference between the briefly versus extremely delayed video. Although older preschoolers also conclude that the delayed video is not equivalent to their current self, their metarepresentation of self allows them to assess the differential significance of the two tapes with respect to their current appearance.

Developing a General Understanding of the Self in Time

In our most recent work we have explored the development of preschoolers more general understanding of how the past and present interrelate—an understanding that goes beyond temporal transitions in the self's physical appearance. Indeed, our model of the development of the child's understanding of the temporally extended self suggests that older, but not younger, preschoolers ought to understand how events in the world in which they have participated causally connect to the present state of the world—even when these events do not directly involve alterations of the self. In a series of six studies, we recently explored the ability of young children to understand how the very recent past is causally bound to the present (see Povinelli et al., 1999). In particular, we sought to determine if we could detect a parallel between children's understanding of alterations of the self through time and alterations of the external world through time.

We initially tested this idea by introducing 3- and 4-year-old children to two empty boxes along a wall. After the children saw that both were empty, one experimenter sat down between the boxes. The other experimenter seated the children at a table so that their backs were to the boxes (and the other experimenter) and then proceeded to play a game with the children. About halfway through the game, the experimenter who was seated between the boxes silently took out a familiar puppet, held it up, and placed it inside one of the two boxes. Although the children were unaware that this event had happened, a video camera clearly captured them playing the game, the experimenter behind them, and her actions as she hid the puppet.

Approximately 2 minutes later the children were turned around to face the boxes and were invited to watch themselves on a video monitor that was placed between the two boxes (thus preserving the veridical left–right position of the boxes on the video). Two brief videotapes were then played for the children (in counterbalanced order). The *self* tape depicted the child playing the game 2 minutes earlier and the experimenter hiding the puppet in one of the boxes; the *other–child* tape was a virtually identical, but prerecorded, image of another child (of the same gender and approximate age) playing the game and the

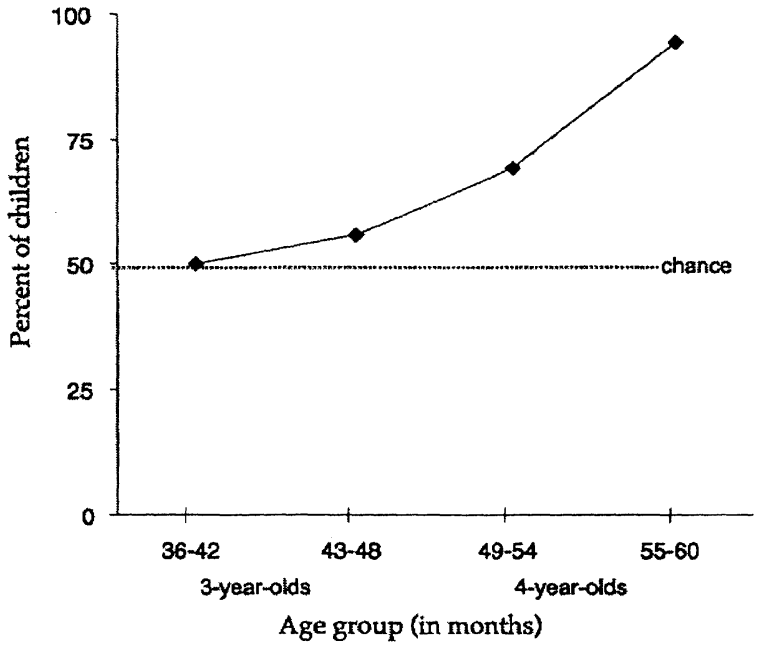

FIG. 5.3 Percentage of children who chose to use the information provided in a videotape of the self (as opposed to a video of another child) to locate a puppet that had been secretly hidden as the child played an unrelated game.

experimenter placing the puppet in the opposite box. The children were then asked to go and get the puppet. In effect, these procedures asked the children whether they grasped that the information in the self tape was relevant to the puppet's current location, whereas information in the other–child tape was not.

As predicted, the children's answer to this question depended on their age (see Fig. 5.3). The 3-year-olds performed at chance levels—they were just as likely to look in either box—suggesting that they did not see any special significance in the information provided in self tape. Also, as in previous studies, this was not because the 3-year-olds failed to recognize their images in the videos: Ninety-four percent of the 3-year-olds correctly identified themselves when they were asked about their image. In contrast, the 4-year-olds, especially the older group, clearly grasped the differing significance of the information about the puppet's location depicted in the self versus other-child tapes. Indeed, a clear

developmental trend was apparent across the four age groups tested (see Fig. 5.3). These results provided some initial support for the idea that the development of young children's temporally extended selves may involve a more general (or parallel) understanding of the causal structure of time.

Several follow-up studies helped to constrain our interpretation of these findings. First, we addressed a critique of our work by Suddendorf (1999), who questioned whether our previous results (and, by implication, these results as well) were simply artefacts of some general difficulty that 3-year-olds might have in understanding how video corresponds to reality. Although several aspects of our previous results cast direct doubt on this critique, we decided to test the issue empirically. For example, in one study, 3-year-olds were shown a single video that depicted a puppet being hidden in one of two boxes. Every child (N = 24) searched in that box when asked to find the puppet (see Study 2 of Povinelli et al., 1999). Obviously, they had no difficulty in understanding the general correspondence between the video images and the objects in the world. This result stands in direct contrast to the results reported by Suddendorf (1999), but are consistent with related findings reported by Troseth (1997).[2] Furthermore, in another study, we conducted a verbal analogue of the puppet task. In it, we provided the information about the hiding incidents through two verbal scripts (without video). One script referred to events that had just happened while they were playing the game, and the other referred to events that had happened "a long time ago," to a different child. Not only did this simple verbal script not help the 3-year-olds, but also it was actually harder for the 4-year-olds! These studies strongly suggest that the results of our tests with 3-year-olds are not due to some general inability to understand the correspondence between video and reality; rather, the difficulty may lie in their inability to understand the extension of the self in time or, perhaps more broadly, the causal arrow of time.

Finally, several additional studies tested even more directly the idea that the older preschoolers (i.e., 4- and 5-year-olds) are explicitly able to understand the causal structure of the extension of the self in time. These studies revealed that when older preschoolers were shown two recent events in which they had participated they understood that the

[2]These discrepancies may be attributable to some specific aspects of the procedure used by Suddendorf (1999). In particular, when the children in his study were shown the video playback of an object being hidden under one of several cups, the image was apparently left–right reversed from the real location of the cups on the table in front of the child. Thus, the children's difficulty in decoding the video information might easily have been the result of this spatial reversal. Note that in our studies (as well as that of Troseth, 1997) this confound was not present.

information from the most recent event was crucial with respect to the current location of the puppet (see Povinelli et al., 1999, Studies 5 and 6).

"JACQUELINE IN THE GLASS": SUMMARY AND FUTURE DIRECTIONS

I opened this chapter by recounting Piaget's (1962) observations of the curious attitude that his daughter, Jacqueline, seemed to adopt toward her image in photos and mirrors, and in particular the dual interpretation she seemed to possess. On the one hand, she clearly understood something about her image and its relation to herself, but on the other hand she seemed to distance herself from the image—as if it were not her at all, but some other Jacqueline. The work reported in this chapter suggests that Jacqueline's reactions are not simply curious anecdotes but rather are manifestations of the various dimensions along which the self is, and is not, explicitly represented at different ages. Indeed, studies of children's reactions to their own images, if properly structured, can reveal striking transitions in how the temporal dimension of the self comes to be grasped by young children.

Clearly, our work is but one thread in an ongoing effort to understand how and when infants and children come to understand the historical and future aspects of the self. Our results highlight the multiple dimensions along which the self may be represented—both in the here and now and in the past. As always, however, numerous fascinating questions remain waiting to be explored. For example, are there other transitions in the child's ontology of time not captured by our simplistic model? For example, do 3-year-olds possess an explicit notion of the past, present, and future but simply not grasp the causal relations that bind successive states of the world together? Perhaps even more interesting, do the transitions I have documented in this chapter have implications for the child's imagistic representation of past events? For example, as children gain an increasingly sophisticated ability to think about the self in time, does this allow them to imagine specific representations of their own bodies in these previous events—allowing them to imagine the self in previous events from a third-person point of view (a view they never actually had)?

Finally, these studies highlight the importance of the still unanswered question that motivated me to conduct these studies in the first place: whether chimpanzees, who share with human infants the ability to recognize themselves in mirrors, also develop an understanding that they are unique and unduplicated selves, caught ever–changing in the irreversible dimension of time.