

A Behavior Analytic Interpretation of Theory of Mind

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ABSTRACT

The inference that others are subject to private events is almost universal among humans. Since no one has direct access to another person's private events, we have proposed this inference occurs because of: 1) The almost simultaneous occurrence a child's private kinesthetic stimuli and the visual stimuli produced by another person's motor act during imitation of motor acts; 2) The similarity between the child's vocal behavior and that of another person during vocal imitation; and 3) The stimulus equivalence that occurs when the child's behavior and similar behavior of others are given the same name. We have proposed that perspective taking is a very common activity in our daily lives and that performance on false belief tests is a special case of perspective taking. In our analysis of the prerequisites for successful predictions on false belief tests we have considered false belief tests as primarily predictions concerning the behavior of others in situations in which discriminative stimuli are available to the child being tested and not to the protagonist about whom the child is to make a prediction. Predictions about other's behavior are made on the basis of three types of prior observations and descriptions: (a) observation and descriptions of the behavior of a specific individual in similar situations; (b) observation and descriptions of the behavior of many different people in similar situations; and (c) observation and descriptions of one's own behavior in similar situations. Success on the false belief tests necessitates discrimination between the stimuli available to the child and those available to the protagonist. *Keywords:* perspective taking, false beliefs, private events, imitation, children with disabilities.

RESUMEN

La inferencia de que otras personas tienen eventos privados es casi universal entre los humanos. Dado que nadie tiene acceso directo a los eventos privados de otra persona, proponemos que esta inferencia ocurre por las siguientes razones: 1) la ocurrencia casi simultánea de los estímulos cinestésicos privados del niño y de los estímulos visuales producidos por otra persona; 2) la similitud entre el comportamiento vocal del niño y el de otra persona durante la imitación vocal; y 3) la equivalencia de estímulos que tiene lugar cuando se da el mismo nombre al comportamiento del niño y a comportamientos similares de otras personas. Hemos propuesto que la toma de perspectiva es una actividad muy común en nuestras vidas cotidianas, y que la actuación en las pruebas de falsa creencia es un caso especial de toma de perspectiva. En nuestro análisis de los prerequisites para obtener predicciones exitosas en las pruebas de falsa creencia, hemos considerado dichas pruebas, principalmente, como predicciones con respecto al comportamiento de otros en

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situaciones en las que los estímulos discriminativos están disponibles para el niño que se somete a la prueba, y no para el protagonista acerca del que el niño debe hacer la predicción. Las predicciones sobre el comportamiento de otros se realizan en función de tres tipos de observaciones y descripciones previas: (a) observación y descripciones del comportamiento de un sujeto específico en situaciones similares; (b) observación y descripciones del comportamiento de muchas personas diferentes en situaciones similares; y (c) observación y descripciones del propio comportamiento en situaciones similares. El éxito en las pruebas de falsa creencia precisa de la discriminación entre los estímulos disponibles para el niño y aquellos disponibles para el protagonista.

Palabras clave: toma de perspectiva, falsas creencias, eventos privados, imitación, niños con deficiencias.

Since Premack and Woodruff (1978) first used the term “theory of mind” in their classic article “Does a chimp have a theory of mind?” there have been numerous articles that have used the term “theory of mind” when reporting research on children’s behavior. Salzinger (2006) reported that when he entered “theory of mind” into Psych-Info there were 2,176 entries of articles, books and chapters. While cognitive psychologists have been preoccupied with behavior that they maintain demonstrates that young children have a “theory of mind,” only a few behavior analysts have dealt with the phenomena (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001; LeBlanc, Coats, Daneshvar, Charlop-Christy, Morris, & Blake, 2003; McHugh, Barnes-Holmes, & Barnes-Holmes, 2004, 2006; Spradlin & Brady, 1999).

Child research literature in which the term “theory of mind” occurs typically discusses two classes of behavior: First, a class of behavior that suggests that children are inferring that other people have private experiences; second, a class of behaviors in which a child is taking or is asked to take the perspective of some other animate being. The false belief tests that typically occur in “theory of mind” research involve a special class of such perspective taking. In the current article we will: (a) note why people are interested in “theory of mind,” (b) describe some behavior that suggests that children are inferring other’s private events, (c) discuss the origin of inferences of other’s private events and perspective taking, (d) describe false belief tests as a special case of perspective taking, (e) speculate on the experiences necessary for success on false belief tests, and (f) discuss groups of children who are delayed in perspective taking and fail false belief tests.

WHY THE INTEREST IN “THEORY OF MIND?”

Development of a theory of mind has been of keen interest to researchers concerned with cognitive and language development in children, particularly children at risk for delayed development. Children’s performances during various theory-of-mind tasks have been associated with higher-level language behavior such as pretending, and lying. In addition, some theorize that theory-of-mind tasks are tapping into basic social processing, or the ability to understand and participate in many social interactions (Baron-Cohen,

1999). Children who have impairments across many aspects of social interaction, including children with autism, would be expected to show poor performance on other social tasks in addition to theory-of-mind tasks because of a common underlying disturbance. In accordance with these theories, poor performance on social behaviors that occur at developmentally earlier periods, such as joint attention, are also likely to be impaired in children with autism. Thus, poor performance on theory-of-mind tasks may provide diagnostic information relative to type of developmental disorder. That is, children who have similar levels of measured intelligence may perform differently on theory-of-mind and other perspective taking tasks. Individuals diagnosed with some type of autism spectrum disorders perform more poorly than individuals with similar levels of intelligence who do not have a diagnosis of autism spectrum disorder (Baron-Cohen, 1999). Later in this paper we will speculate why this may be true.

BEHAVIOR THAT SUGGESTS THAT CHILDREN ARE INFERRING OTHER'S PRIVATE EVENTS AND PERSPECTIVE TAKING

An early behavior that, according to some theorists, is related to a developing theory of mind is the alternation of the child's orientation toward an object and another person's eyes (joint attention or gaze shift) (Baron-Cohen & Swettenham, 1997; Carpenter, Nagell, & Tomasello, 1998; Flavell, 1999; Golinkoff, 1993; Tomasello, 1999). Joint attention appears within the first year of life for typically developing infants. This shift in gaze between object and person enables the child to "check in" with the other person and see if the other person is looking at the same object as the child. Thus, it may be an early indication that the child is "shifting perspective" between themselves and the other person.

Sometime later, usually at around 12 months, infants will exhibit a more advanced form of joint attention when they not only shift their gaze, but also point to distant objects. Frequently, such pointing will be accompanied with an infant vocalization (Butterworth, 2003; Franco & Butterworth, 1996). These vocalizations can help communication partners respond to pointing in predictable ways. For example, Wetherby, Alexander, & Prizant (1998) presented an anecdote that strongly suggests that a 20-month-old child was inferring what his mother was seeing. The child, upon seeing a flag hanging in the street said "Fag, fag," when the mother said "What?" the child repeated "Fag, fag" while pointing at the flag. Again the mother said "What?" The child again pointed at the flag and said "Tag, tag." When the mother said, "Oh, pretty flag," the child smiled and stopped pointing. This suggests that the child was attempting to get the parent to see what the child was seeing, and to label the object with a familiar label.

Other aspects of children's early verbal development suggest that they are attributing subjective experiences to other people or animals while playing with a doll or pet. Early in development young children begin saying things that suggest that they are attributing subjective experiences to other people or animals. For example they might say something like "Baby hungry" or "Doggie hurt." Moreover a little later, young children are able to identify and name emotions such as fear, sadness, or anger in other persons. Of

course children learn to do this by hearing other people, such as parents, use these same descriptor terms (Hart & Risley, 1995; 1999).

POSSIBLE ORIGIN OF CHILDREN'S INFERENCES OF OTHER'S PRIVATE EVENTS AND PERSPECTIVE TAKING

While the development of children's attribution of private experiences to others is clearly related to their development of verbal behavior, even before the child is a speaker and listener, the basis for such inferences may be developing. With the exception of the act of speaking, the stimuli impinging on an actor and those impinging on an observer are quite different (Gibson, 1959; Goldiamond, 1962). For example, if a person waves a hand or scratches his/her head, the stimuli impinging on the actor will include tactile and kinesthetic stimuli (private events) that are not available to an observer, for whom the primary stimuli will be visual. Since the stimuli impinging on the actor and those impinging on the observer are so different, how does the infant as actor come to see his actions in a way similar to that in which an observer sees them? By 6 months of age, infants begin to pat their image on the mirror and by about 18 months of age they show evidence of self-recognition. Self-recognition has been demonstrated through the mirror rouge task (Lewis & Brooks-Gunn, 1979). In this task, infants are placed in front of a mirror and their responses are recorded. Then, an experimenter places a small amount of rouge on the child's nose. Then the infant is placed back before the mirror. If the infant looks in the mirror and touches his/her nose, the infant is said to demonstrate self-recognition. A mirror is a perfect device for establishing a primitive relationship between the private kinesthetic stimuli produced by an action, to the public visual stimuli that is seen by an observer.

Once the child has developed an imitative repertoire, the child is subject to his/her own kinesthetic stimuli nearly simultaneously with the visual stimuli of the other person during imitation. As imitation becomes more complex and delayed, the child who engages in delayed imitation is subject to private stimuli analogous to those of the person observed. For example, the stimuli impinging on a person wrapped in a comfortable blanket are quite different from those of an observer, however we consider the stimuli impinging on the blanket user public, because the observer can replicate the experience simply by wrapping him/herself in a blanket. We believe that imitation is the first step in primitive perspective taking.

While many of the skills that lead to inferences concerning the private experiences of others are a function of vocal verbal behavior, imitation of motor acts also appears critical to the development of perspective taking. Evidence for the importance of imitation of motor acts in the development of perspective taking can be found in research with individuals who are profoundly blind. Children who are blind are precluded from imitation of a visual model. They are also precluded from developing the joint visual attention that occurs so early among typically developing seeing children. Reports that children who are blind are late in their use of emotional and mental terms as well as delayed in their performance on false belief tests (Brandsborg, 2002; McAlpine & Moore, 1995; Minter, Hobson, & Bishop, 1998) indicate that vision is involved in the development

of inferences concerning the private experiences of others. The hypothesis is that since blind children cannot visually imitate another, they are delayed in development of perspective taking and related tasks.

Vocal and verbal imitation is also important for the development of perspective. Unlike pure motor acts in which the stimuli impinging on the actor are largely kinesthetic and the stimuli impinging on the observer are primarily visual, the auditory stimuli produced by a vocalization impinge on both the speaker and the listener. While there are kinesthetic stimuli impinging on the speaker that do not impinge on the listener, the auditory stimuli produced by the speaker are available to both the speaker and the listener. It is likely that this feature of vocal responses plays a role in the early development of attributing private experiences to others. Infants vocalize and frequently the consequence of such vocalization is an imitative vocalization on the part of the parent. It is likely that the similarity of these vocalizations to the child's own vocalizations forms a basis for the early inference of private experiences of others.

If our analysis of the effects of the early vocal interactions of infants and adults is somewhat correct, it is not surprising that deaf children are delayed in attributing private experiences to other persons (Peterson & Siegal, 2000; Steeds, Lowe, & Dowker, 1997).

While B. F. Skinner (1945, 1953, 1957, 1964) didn't discuss inferences attributing private experiences to others, he has discussed the development of tacting private events extensively. Skinner noted that while many of the stimuli that controlled behavior were in the person's external environment and thus shared by other people, some stimuli were within the person's skin and hence available only to that person (private stimuli). Skinner presented a description of how the community teaches individuals to tact private stimuli although the community never has direct access to those private stimuli. First, there are often "public accompaniments" to private stimuli. For example, if a child experiences a sharp blow, cut, or scratch, the parent will very likely teach the child to tact the private pain stimuli. The parent doesn't feel the pain, but does respond to the accompanying stimuli.

Second, a more common way in which children learn the names for private events involves "accompanying public behavior." For example a child with a headache may cry and hold his head. Such behavior may lead the parent to teach the child to tact the private stimuli of pain. It is quite likely that the conditions that result in children tacting private events involve both public accompaniments and accompanying public behavior. For example, if a parent observes that a child's doll has been broken and the child is crying, the parent may say to the child "You're sad because your doll is broken." In which case, both the broken doll (public accompaniment) and the child's crying (accompanying public behavior) control the parent's response. So children are being taught to tact their private events. However, they are also learning to tact the behavior of others in similar situations or with similar reactions.

The motor and vocal imitation cited above provide for an early and primitive form of perspective taking. Skinner's analysis of how children are taught to tact private events provides another basis for inferring that others have private experiences. However, it is not quite enough to tact one's own private events, there must be a linkage of one's

private experiences and the behavior of the other person. The literature on stimulus equivalence provides for such a linkage. If two initially independent stimuli become linked to a third stimulus, they will be linked to each other (Sidman, 1971; Sidman & Cresson, 1973; Sidman, Cresson, & Willson-Morris, 1974; Spradlin, Cotter, & Baxley, 1973). According to the stimulus equivalence literatures, one person's private events should become linked to another person's public behavior if the private events and the public behavior are given a common name or description. For example, a child may cry and have a parent say that the child is "unhappy." Later that same child may see and hear another child cry and hear the parent say that child is "unhappy." Through that common "unhappy" name the child may come to associate his/her private event related to unhappiness to other people's public unhappy behavior.

We have provided three likely pathways for the development of children's inference that other people have private experiences: (a) the nearly simultaneous impingement of private kinesthetic stimuli produced by their own behavior, and the visual stimuli produced by another's behavior during motor imitation; (b) the occurrence of similar vocalizations of the child and caretaker during vocal imitation; and (c) the linkage of private stimuli of the child and public stimuli of others by linking each to spoken words (equivalence). With these three sources of linkage of private and public events, attributing private experiences to others seems almost inevitable.

As we have described the development of inferences of private events of others, it seems to be largely a passive process. However, if we take a step forward we see perspective taking as related to the issue of inferences of others' private events, but we see it as a more active process. Most would agree that successful social interaction is dependent on being able to take the perspective of other people to show understanding, empathy, and to respond in predictable ways to a variety of social stimuli. Many forms of perspective taking are based on shared interaction with the physical world. For example, a child may be shown a card with a different picture on each side. If the child has learned to name each picture and to state what is on the opposite side when viewing one side of the card, the child will very likely be able to say what he/she sees and what an observer on the other side sees. Or a child who has been outside on cold snowy days, upon seeing another child outside in the snow without a coat, may say the other child is cold and that he/she needs a coat. Many small acts of kindness seem to be based on such perspective taking. For example, upon seeing a friend shiver in a chilly room, one might offer the use of a sweater or jacket. Or upon seeing a person loaded with packages approaching a closed door, one will step forward and open the door.

Much of perspective training takes place in a context of children's picture books. For example a child might be asked, "What would you do if you woke up and there were three bears at your bed?" Or, "How do you think Bambi felt when his mother was shot?" Or "What did Henny Penny think was happening when an acorn fell on her head?" Note that in each case, the feelings, or thoughts are inferences based on what the child him/herself has felt or would feel under analogous conditions.

Children are also given training in perspective taking in the context of their social interactions with siblings and peers. For example, a child might be asked, "Do you think Sally (your sister) will be happy when she sees her new dress?" Or upon

breaking her sister's doll, "How would you feel if someone broke your doll?" Note that in each of the teaching examples the child is asked to make a simple prediction either about their own feelings, thoughts, or overt behavior, or about the feelings, thoughts, and overt behavior of others. However, once again predictions about the feelings and thoughts are based on what the child would feel or think under analogous conditions. The child has no access to another person's private events. In the following sections we will examine a specific subclass of perspective taking; namely, false belief tests.

FALSE BELIEF TESTS (TESTS FOR A SPECIFIC TYPE OF PERSPECTIVE TAKING)

False beliefs are commonplace in our daily lives. They range from such mundane situations as mistaking a person seen at a distance for a friend when in fact she or he is a stranger, to invading a country on the false belief that the country has weapons of mass destruction. Acts of deception are based on inducing others to believe something that is counter to fact. Much humor is based on creating a false belief that is then quickly dispelled. Practical jokes such as putting a clear plastic cube with an imbedded fly into a friend's drink are based on creating a false belief. The recognition that other people can have false beliefs is considered by some to be conclusive evidence of a theory of mind (Dennett, 1978; Perner, Leekam, & Wimmer, 1987).

While there are innumerable ways of evaluating whether a child might recognize that another person might act on the basis of a false belief, typically three primary types of tasks have been used to test for a child's understanding of false belief: the unexpected transfer tasks (Wimmer & Permer, 1983), the unexpected identity tasks (Perner *et al.*, 1987), and the misidentified objects tasks (McAlister & Peterson, 2006). Success on each of these three common false belief tests involves a specific type of perspective taking; namely, taking the perspective of a protagonist who has been subject to stimulus conditions that differ from those available to the child being tested.

In the unexpected location tasks, Person A or Puppet A puts an object in a specific location. While Person A or Puppet A is away, the object is placed in another location. The child who is being tested is to say where Person A or Puppet A will think the object is or look for the object when he/she returns. If the child says that Person A or Puppet A will look where he/she placed the object, the child passes the task. If the child says the person/puppet will look where the object is now, he/she will have failed the test item. In a variant of the unexpected location task, the puppet is positioned in front of the initial location and the child is asked why the puppet is looking there. If the child says because the puppet thinks the object is there he has succeeded. If not the examiner asks what the puppet thinks. The answer that the puppet thinks the object is there gets partial credit.

The false identity task involves showing the child a box that usually contains a specific type of item. For example, the child is shown a candy box and asked what's in it. The child says candy. The box that contains the unexpected object (a pencil) is then opened and shown to the child. The child is then asked what a child who has not seen the box opened will think is in the box. If the child says candy, he/she will have passed the test, if the child says pencil, he/she will have failed the test.

The misidentified object task involves showing a child an object that looks like another object. For example, the child might be shown a sponge that appears to be a rock. The child is asked to name the object. The child says "rock." The child is then allowed to hold and inspect the sponge and then asked again to name it. The child says "sponge." Now the child is asked what another child will think the object is. If the child says rock, she/he will have passed the test and if he/she says sponge he/she will have failed the test.

There are numerous variations of these tests and usually a series of control questions are also asked to determine that the child has understood the directions provided in the task. However, the basic tests are as described above. Note that in each of these false belief tests, the child being tested is asked to predict what a protagonist who does not have access to the same stimuli as the child will say or do. In each case the child must discriminate between the stimuli currently available to him/her and the stimuli available to the protagonist.

FALSE BELIEF TESTS PERFORMANCE AS BEHAVIORAL PREDICTIONS BASED ON PAST OBSERVATIONS

In each of the basic false beliefs tasks, the child is asked to predict what another child or puppet will do or think when confronted with a particular situation (LeBlanc *et al.*, 2003), or explain why a puppet has behaved in a specific way. Predictions are based on three kinds of past observations. First, if the child has observed a specific person in similar situations on many different occasions, the child might predict on the basis of what the other person or character has done in similar situations. Second, if the child has observed many different people in similar situations, the child might predict on the basis of what most did in similar situations. Third, the child can predict what another person would do in a specific situation based on what the child has done in similar situations. The child engaged in a false belief test will not have observed the person or puppet's behavior on previous false belief tasks, so success depends heavily on the second and third kind of observations. That is, what a child says that a puppet or child will do or think in a false belief task depends heavily on what the child has observed other people do or on what the child, him/herself, has done or thought in similar situations.

THE VERBAL ENVIRONMENT AND THE DEVELOPMENT OF OBSERVING BEHAVIOR RELEVANT TO SUCCESSFUL PREDICTION

Typically developing children become successful in performing on false belief tests at between 3 and 5 years of age (Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge, 1996; Lewis & Osborne, 1990). The age at which typically developing children are successful on false belief tests varies and is related to their verbal skills (Asherton & Jenkins, 1999; Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Lewis, Freeman, Hagestadt, & Douglas, 1994; Lewis & Osborne, 1990). Lewis and colleagues conducted a series of studies that demonstrated that children's performances

on false belief tests were highly related to their narrative skills. That is, children who could describe the sequence of events involved in a false belief test coherently nearly always succeeded on the false belief test, while those who did not demonstrate such good narrative skills often failed.

If children are to make predictions of behavior based on observations of others' behavior or their own behavior they must have learned such observing behavior. While there are some contingencies that would establish observing behavior that do not involve verbal behavior, many of those that establish observing behavior are placed on verbal behavior. Children typically learn descriptive or narrative skills concurrently with observing skills. Hart and Risley (1995, 1999) provide numerous examples of parent child interactions that illustrate the type of social interactions that would lead to the development of observation of present and past behavioral sequences and narrative skills of the type that Lewis found related to success on false belief tests. As one reads Hart and Risley's transcripts, it becomes apparent that the interaction of parents and infants is providing opportunities for the development of a wide variety of verbal behavior, including tacting and manding objects and actions, and tacting the child's own current and past behavior from infancy through early childhood. Of special relevance to our discussion of false belief tests are the interactions that lead to narrative skills involving current and past behavior and events. Hart and Risley noted that when children were about 2 years of age, parents began to ask frequent questions about past behavior. "Did you wash your hands?" or "What happened?" Initially, parents might accept nearly anything the child said, however parents might also ask for or prompt additional comments about past actions and events. As children are learning to describe their current and past behavior they are also learning the occasions in which such terms as "think" and "know" occur. According to Hart and Risley, 41 of 41 parents used the word "know" when the children were between 11 and 24 months and 38 of 41 children also used the word "know" between 25 and 30 months All 41 parents used the word "think" and 34 of 41 children also used the word "think." While Hart and Risley provide many examples of opportunities for the child to describe his/her own behavior, there are fewer examples of interactions that would teach the child to describe other people's present or past behavior or that would provide narratives involving prediction of other's behavior. When such examples did occur, they often involved characters in a children's book. Now if the examples given by Hart and Risley are representative of the interactions that occurred between parents and children during the first 3 years of life, it is not surprising that many 3-year-old children would not succeed on false belief tests, since few of the interactions are focused on describing or predicting other people's behavior. In fact studies have shown that maternal use of cognitive terms, particularly terms that describe another's mental states are significantly correlated to performance on false belief tasks (Slaughter, Peterson, & Mackintosh, 2007).

Children who are older than 3, presumably spend more time with playmates than do children who are younger than 3. Between 3 and 5 many children begin to play games such as hide and seek, hide the button, variations of 20 questions. These games highlight and teach differences in stimuli available to different participants. In hide and seek games, the children who are hiding know where they are, the child designated as

“it” does not. In the hide the button game, the child who hides the button knows where it is. The other children do not. Likewise, in a variation of the 20-question game, one child knows the target object or number. The others do not. These games provide an excellent opportunity for the child to learn to discriminate between stimuli available to him/her versus stimuli available to others.

In addition to these common games, children are having numerous interactions that require descriptions that include both their own behavior concurrently with the behavior of others. For example, rather than being asked solely for a description of their own behavior they may be asked to describe their joint behavior. For example parents ask questions like, “What are you and Suzie doing?” A response such as “We’re playing star wars” will probably satisfy the parent. Or a parent may ask, “What did you and Suzie do?” A response such as “Suzie’s Mom took us to McDonalds” would suffice. Finally, a parent might ask “What are you and Susie going to do?” Once again a relevant response will suffice. If the child does not answer or answers incorrectly the parent may repeat the question or perhaps provide a relevant answer. There are also opportunities for a child to learn to discriminate the stimuli available to them and the stimuli available to other children. For example, suppose a child’s grandmother has just arrived for a visit, her brother has not yet returned from school. The mother might say, “I’ll bet Bobbie will be surprised. He doesn’t know Grandma is here.” Children with siblings succeed on false belief tests at an earlier age than children without siblings (McAlister & Peterson, 2006). Our hunch is that when a child has a sibling that is close in age, interactions such as the one described above lead the child to make better predictions concerning the behavior of others, including the predictions on false belief tests.

Analysis of false identity test performance. Now let us consider the false identity task. As noted above, the false identity task involves showing the child a box that usually contains a specific type of item. For example, the child is shown a candy box and asked what’s in it. The child says candy. The box that contains the unexpected object (a pencil) is then opened and shown to the child. The child is then asked what a child who has not seen the box opened will think or say is in the box. If the child says candy, he/she will have passed the test, if the child says pencil, he/she will have failed the test. Once again to be successful the child must understand the verbal directions. Children have numerous opportunities to observe other’s behavior in response to boxes that typically hold a specific content and possibly could make accurate predictions concerning what the protagonist would say or believe based on those observations. However, we believe that children are basing their predictions on their own behavior in the test situation before they had seen the contents of the box. In other words they said or believed “candy” was in the box prior to it being opened and they predict that the protagonist will behave as they did prior to the box being opened. A child who does not discriminate between his/her behavior prior to the box being opened and after it was opened will fail this false belief test. Lewis and Osborne (1990) noted that many children who fail the false identity test by saying “pencil” also say “pencil” when asked what they thought was in the box before it was opened. The discrimination between the stimuli controlling his/her initial response and the stimuli available for control after the

box is opened is critical to give an appropriate response to the false identity task. The failure to discriminate these sources of stimulus control will lead the child to respond on the basis of stimuli available after the box is opened, rather than to the stimuli available prior to the box being opened, and hence lead to inadequate performance on the false belief test. The importance of a highly developed verbal repertoire is illustrated by the effects that a slight change in wording can have on performance on false belief tests. Lewis and Osborne (1990) found that a higher percentage of children would pass the false identity task if asked "What will _____ think is in the box when the top is still on?" than if asked "What will _____ think is in the box?"

Analysis of the misidentified object test performance. The misidentified object test would appear to be quite similar to the false identity task. However, the typical child probably has had far less opportunities to observe other people when they misidentify objects than when they find that a box does not contain the pictured object. There are some occasions such as plastic fruit or plastic flowers that initially appear to be real, but children will rarely have had opportunities to observe people say that an object is one thing and then upon feeling it for themselves, find that it is something else. So responses to the misidentified object test will be even more likely when a child has had repeated opportunities for more complete inspections of the object. The child must predict what another child will think or do on the basis of visual stimuli alone, rather than on the basis of the additional tactile stimuli that is available to the child after he has felt the object. Once again the child must discriminate between the stimuli (including private stimuli) currently available to him/her and those available to the child who has not been privy to the tactile inspection.

Analysis of unexpected transfer task test performance. In the unexpected transfer tasks Child A or Puppet A puts an object in a specific location. While Child A or Puppet A is away, the object is placed in another location. The child who is being tested is to say where Child A will look for the object when he/she returns. If the child says that Child A or Puppet A will look where he/she placed the object, the child passes the task. If the child says the child/puppet will look where the object is now, he/she will have failed the test item. It goes without saying that the child must understand the question to be successful. In addition, to be successful the child must observe where the puppet initially placed the object. Second the child must remember where the object was initially placed. Third, the child must have learned that people generally look for objects where they were last seen or have placed them. The child from a well organized home will have had numerous opportunities to observe that other people look for objects where they placed them. If the child observes the mother place the jelly jar in the pantry, the mother will generally look for the jam jar in the pantry. Moreover, the child will have had numerous opportunities to place objects and look for them. Most often, looking where one placed the object will be reinforced. Less frequently, a child may have seen someone place an object in one place and have someone else move the object and then observe the first person look for the object where he/she initially placed it. Probably more frequently, the child will have had personal experience in placing an object in one place and having a sibling or parent place the object somewhere else. Even though the child has had many observations of people looking for an object where

they placed it, the current stimuli controlling the child's response may override that history. In order to succeed, the child must discriminate between the stimuli available to him/herself and the stimuli that will control the puppet's looking behavior.

Once again, subtle changes in phrasing the question affects the proportion of children who succeed on the false belief test. Lewis and colleagues (1994) found that a higher proportion of children solved the unexpected location task when asked where the puppet would look for the object than when asked where the puppet would think the object was. Is it possible that asking the child where the puppet will think the object is leads the child to assume that the puppet has access to the same private stimuli as the child being tested, while asking where the puppet will look for the object does not? Or, alternatively, the simpler syntactical structure in the question regarding looking may be easier for the child to understand (Asherton & Jenkins, 1999).

CHILDREN WHO ARE DELAYED IN INFERRING OTHER'S PRIVATE EVENTS AND PERSPECTIVE TAKING

While most typically developing children perform successfully on false belief tests by the time they are 5 years old, there is considerable variation of the age at which children become successful. As a group, children without siblings are delayed relative to those with siblings. Moreover children whose parents interact less with them and use fewer subjective terms are delayed. According to Hart and Risley's data, it is not surprising that children whose parents talk less to them are delayed in language development. Moreover, since the words that children use mirror those of the parents, it's not surprising that children whose parents use less subjective terms are delayed in their use of subjective terms. But why should lack of use of subjective terms affect performance on false belief tests? Subjective terms such as "intend" and "think" are likely to occur in situations involving description and prediction of behavior. The term "intend" suggests subsequent action and allows for the prediction of that action. The term "think" occurs in an uncertain context, nevertheless the term suggests certain sequences are more likely than others. For example if a parent says, "I think there is ice cream in the refrigerator," the outcome of seeking ice cream in the refrigerator is likely to be different than if the parent says "I don't think we have any ice cream."

While there are differences among typically developing children in perspective taking, the differences pale when compared to the delays in perspective taking of children who are blind, deaf, or autistic. Children who are blind or deaf are delayed in their use and understanding of subjective terms. It is very likely that these delays, in addition to being a function of basic problems in imitation of motor acts for blind children, and limitation of imitation of vocalizations for deaf children, also involve problems of stimulus equivalence. Blind children will not have had access to the visual stimuli that make the linkage between their private feelings and visual stimuli of other's behavior possible. Deaf children will have access to visual stimuli produced by another person and their private kinesthetic events during imitation. But in the absence of a well-established sign language they will not have access to the naming responses that would link private events with the public behavior of others. However, deaf children

of deaf parents would likely have both their own behavior and that of others labeled through sign language, hence linking their private events with the public behavior of others. Peterson and Siegel (2000) noted that deaf children of deaf parents performed correctly on false belief tests earlier than did deaf children of hearing parents. This suggests that parent-child communication, regardless of whether it is spoken or signed, is a critical factor in perspective taking.

Children with autism are a third group of children who appear delayed in their inferences concerning the private event of others. Children with autism present a problem for our hypotheses concerning the development of inferences concerning the private events of others. Most autistic children who show these deficits are not blind or deaf. Moreover, some have developed verbal behavior that superficially approximates that of typically developing children. So theoretically they should learn to infer private events of others as readily as typically developing children. However, as Spradlin and Brady (1999) noted, children with autism are subject to a variety of problems of stimulus control. First, numerous studies have demonstrated overselectivity among children with autism (Lovaas, Koegel, & Schreibman, 1979; Lovaas & Schreibman, 1971). Second, and possibly as a function of overselectivity, children with autism are limited in motor imitation (Charman, Baron-Cohen, Swettenham, Baird, Cox, & Drew, 2000; Hobson & Hobson, 2007; Osterling & Dawson, 1994; Stone, Lemanek, Fishel, Fernandez, & Altemeier, 1990). As noted above motor imitation provides a pathway for the development of a relation of one's private events and the public behavior of others. A problem with motor imitation could lead to a failure to develop a relation between one's private events and the public behavior of others. Third, autistic children may be limited in their acquisition of stimulus equivalence (Eikeseth & Smith, 1992). If so, another pathway to the attribution of private events to others would be limited. Fourth, children with autism may have difficulty discriminating their behavior from the behavior of others. Difficulties with learning to use pronouns have been attributed to this discrimination difficulty (Hobson & Hobson, 2007). Finally, many children with autism are less reinforced by social interactions than are typically developing children. Thus they may not be attuned to inferences about other people.

SUMMARY

The inference that others are subject to private events is almost universal among humans. Since no one has direct access to another person's private events, we have proposed this inference occurs because of (a) almost simultaneous occurrence of a child's private kinesthetic stimuli and the visual stimuli produced by another person's motor act during imitation of motor acts, (b) similarity between the child's vocal behavior and that of another person during vocal imitation, and (c) stimulus equivalence that occurs when the child's behavior and similar behavior of others are given the same name. We have proposed that perspective taking is a very common activity in our daily lives and that performance on false belief tests is a special case of perspective taking.

In our analysis of the prerequisites for successful predictions on false belief tests we have considered false belief tests as primarily predictions concerning the behavior

of others in situations in which discriminative stimuli are available to the child being tested and not to the protagonist about whom the child is to make a prediction. We believe that predictions about the behavior of others are made on the basis of three types of prior observations and descriptions: 1) Observation and descriptions of the behavior of a specific individual in similar situations; 2) Observation and descriptions of the behavior of many different people in similar situations; 3) Observation and descriptions of one's own behavior in similar situations.

We hypothesize that observation and descriptions of other people in similar situations and observation and descriptions of one's self in similar situations serve as the basis of accurate prediction on false belief tests. Success on the false belief tests necessitates discrimination between the stimuli available to the child and those available to the protagonist. Children's performance on false belief tests are largely determined by extensive past experiences, that are largely unavailable to children who are profoundly blind and children who are deaf, unless their parents are fluent in sign language. We remain perplexed by the failure of children with autism, however we speculate that stimulus control problems such as overselectivity, failure to imitate, and problems in developing stimulus equivalence, play a role in the reported delays on false belief tests.

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