It's Not What You Know, It's Who You Know: Older siblings facilitate imitation during infancy

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It's Not What You Know, It's Who You Know: older siblings facilitate imitation during infancy

Ce n'est pas ce que vous savez, c'est qui vous connaissez: des enfants plus âgés facilitent l'imitation pendant la petite enfance

No es lo que sabes, sino a quién conoces: los hermanos mayores facilitan la imitación durante la infancia

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ABSTRACT *In this study, we investigated the effect of older siblings on imitation by infants under naturalistic conditions. To do this, 300 parents provided diary records of imitation by their 12-, 15-, and 18-month-old infants. Half of the infants were only children and half had older siblings. Infants of all ages acquired one to two new behaviours per day through imitation. There were also age-related and sibling-related changes in the quality of behaviours acquired through imitation. Older infants imitated more multi-step sequences and substituted more objects during re-enactment than younger infants. In addition, infants with siblings imitated more behaviour without explicit instruction than did infants without siblings. Furthermore, imitation by infants with siblings was characterised by a higher level of pretence and rough-and-tumble play. These findings converge with both observational and laboratory-based research confirming that imitation is a powerful mechanism by which infants acquire new behaviours in the course of their everyday lives.*

RÉSUMÉ *Dans cette étude, nous avons examiné l'effet des frères et des sœurs aînés sur l'imitation par des enfants en bas âge dans des conditions naturalistes. Pour faire ceci, 300 parents ont fourni des dossiers de journal sur des exemples d'imitation par leurs petits enfants de 12, 15 et 18 mois. La moitié des petits enfants étaient des enfants uniques et l'autre moitié avait des frères et des sœurs aînés. Les enfants de tous les âges ont acquis 1 à 2 nouveaux comportements par jour par l'imitation. Il y avait aussi des changements relatifs à l'âge et à la présence des frères et des sœurs dans la qualité de comportements acquis par l'imitation. Les enfants plus âgés tendaient à imiter les séquences de plus d'étapes et tendaient à substituer plus d'objets pendant la répetitition que les enfants plus jeunes. En outre, les enfants*

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avec des frères et des sœurs aînés tendaient à imiter plus le comportement sans instruction explicite que les enfants sans frères et des sœurs aînés. En plus, l'imitation par des petits enfants avec des frères et des sœurs aînés a été caractérisée par un niveau plus élevé de faire semblant et de jeu de dégringolade. Ces découvertes convergent avec la recherche d'observation et de laboratoire confirmant que l'imitation est un mécanisme puissant par lequel les enfants en bas âge acquièrent des nouveaux comportements au cours de leurs vies de tous les jours.

RESUMEN *En este estudio, investigamos el efecto que tienen los hermanos mayores sobre la imitación por los niños menores en condiciones naturalísticas. Para llevar a cargo esto, 300 padres suministraron apuntes de sus agendas diarias de sus infantes de 12, 15 y 18 meses. La mitad de estos niños eran niños únicos y la otra mitad tenían hermanos mayores. Los infantes de todas las edades adquirieron 1 o 2 nuevos comportamientos por día a través de la imitación. Hubieron presentes también cambios relacionados a la edad y al hecho de tener hermanos en el tipo de comportamientos adquiridos a través de la imitación. Los niños mayores tendieron a imitar más las secuencias de pasos múltiples y tendieron a sustituir más objetos durante la reconstrucción que los infantes menores. Además, los niños con hermanos imitaron el comportamiento sin instrucción explícita más que los niños sin hermanos. La imitación de parte de los niños tuvo como característica un alto nivel de simulación y de juego frenético. Estos hallazgos convergen con las investigaciones de observación y de laboratorio, confirmando que la imitación es un mecanismo potente por el cual los niños adquieren nuevos comportamientos durante sus vidas cotidianas.*

Interest in the relation between cognitive and social development has waxed and waned for more than a century. Although many early theorists considered that cognitive and social development were inextricably linked (Morgan, 1900; Baldwin, 1915; Guillaume, 1926/1971; Valentine, 1930), the birth of behaviourism led to the demise of this view; in fact, the issue of development per se was largely ignored for decades. When the cognitive revolution rekindled interest in development, however, children were assessed largely under standard laboratory conditions. This practice limited the opportunity to examine the way in which social interaction moderated the emergence of particular cognitive skills.

Recently, there has been renewed interest in the role that social interaction might play in shaping children's cognitive development. This interest has been motivated, at least in part, by Vygotsky's social constructionist theory (for review, see Wertsch & Tulviste, 1992). According to Vygotsky, all cognitive functions develop in the course of social experience. Only after a child has mastered a skill in a supportive social context will that skill be internalised so that it can be used outside the social context in which it was originally acquired (Vygotsky, 1978).

It is now well recognised that social interaction with parents and other significant adults helps to shape the course of cognitive development during infancy and childhood (e.g. Zahn-Waxler & Radke-Yarrow, 1975; Fivush & Fromhoff, 1988; Hudson, 1990; Rogoff, 1990; Smith, 1999; Farrant & Reese, 2000). The effect of social experience, however, is not restricted to interactions with adults. Another important source of social experience occurs in the course of children's interactions with other children, particularly their own siblings (Sutton-Smith & Rosenberg, 1970; Lamb, 1978a; Teti *et al*., 1986; Zukow, 1989). Older siblings, like parents, often alter their behaviour to meet the needs of younger children, providing the scaffold that is necessary for young children to learn (Dunn & Kendrick, 1982). Although these socially guided learning experiences comprise a large part of infant cognitive development, little is known about the role of siblings (or peers) in this process.

In the present study, we explored the role of older siblings in imitative learning during the infancy period. Imitation is a potentially powerful mechanism for incidental learning, particularly during the infancy period. A small arsenal of studies has now shown that very young infants can acquire a wide range of new behaviours, simply by watching and repeating the actions of others (Barr *et al*., 1996; Collie & Hayne, 1999; Hayne *et al*., 2000).

The primary aim of our research was to examine imitation in real-world contexts. To do this, we asked parents to keep detailed diary records of their infant's imitation in the course of their daily lives. Using these diary records, we addressed two issues. First, we assessed age-related changes in imitation by 12-, 15-, and 18-month-old infants in the context of their own home environment. Although there has been considerable interest in developmental changes in imitation during this period under standard, laboratory conditions (for review see Barr & Hayne, 2000), we know very little about age-related changes in imitation in real-world contexts.

Second, we assessed the effect of siblings on the quantity and quality of behaviours acquired through imitation. Although prior research has shown that infants readily imitate their older siblings, this research has focused primarily on children with siblings to the exclusion of children without siblings (Lamb, 1978a, b; Abramovitch *et al*., 1979, 1980; Stoneman *et al*., 1984). In the present study, we directly compared imitation by these two groups in an attempt to tease apart age-related and sibling-related effects.

Method

Participants

Three hundred infants (150 male, 150 female) were recruited through public birth records and by word of mouth. The majority of infants were Päkehä (New Zealanders of European decent), and came from a wide range of socio-economic backgrounds. Half of the infants were only children ($n = 150$) and half had older siblings ($n = 150$). One hundred infants (50 male) were 12 month olds (M age = 12.41 months, SD = 0.30 months), 100 infants (50 male) were 15 month olds (M age = 15.32 months, SD = 0.28 months), and 100 infants (50 male) were 18 month olds (M age = 18.35 months, SD = 0.25 months). Diaries for 19 additional infants were excluded because parents completed less than 3 days of observation ($n = 13$) or because parents failed to follow the experimenter's instructions for diary completion ($n = 6$).

Most primary caregivers were full-time, stay-at-home parents. The primary caregivers' employment status did not vary as a function of age, gender, or sibling status. The composition of the families of infants with siblings is shown in Table I as a function of age. For infants with siblings, the gender, age, and number of older siblings were recorded. On the basis of these data, the number of infants who had siblings of a different gender (mixed-sibling families), the number of infants with a pre-school sibling (under age 5 years in New Zealand) at home (closely spaced sibling), and the total number of siblings was also calculated. As shown in Table I, the composition of the families did not vary as a function of the age of the target child (i.e. 12, 15, or 18 months).

Procedure

To maximise the reliability and validity of the diary data, parents were asked to record specific behaviours within a highly structured format for 7 days (see also Anderson *et al*., 1985; Dale *et al*., 1989; Mervis *et al*., 1992). The introduction to the diary explained the rationale for the

TABLE I. The number of infants with siblings, the number of infants with siblings of a different gender (mixed-sibling families), the number of closely spaced siblings, and the total number of siblings in each family, as a function of age

Age (months)	Infants with siblings	Mixed-sibling families	Closely spaced siblings	Number of siblings		
				1	2	3
12	$n = 50$	$n = 29$	$n = 30$	33	14	3
15	$n = 50$	$n = 28$	$n = 30$	35	12	3
18	$n = 50$	$n = 34$	$n = 35$	33	15	2

study and provided detailed instructions and examples of imitation. During the initial visit, the study was explained to the primary caregiver and informed consent was obtained. Parents were told that the purpose of the study was to assess imitation under naturalistic conditions, but they were not told that we were interested in either age-related or sibling-related differences. Parents were familiarised with the procedures they were to use and were informed that an experimenter would be available to answer questions during the week.

Parents recorded their response in a series of columns, labelled action, model, delay, objects, new, where, exact, emotion, spontaneous. For each observation they recorded, parents were asked to describe the action that the child imitated, the model (e.g. mother, brother), the delay between demonstration and imitation, the materials used during imitation, whether the imitated behaviour was new or not, where the event took place, whether the reproduction of the model's behaviour was exact or approximate, the infant's emotional expression, and whether the imitation was spontaneous or instructed.

Results

Scoring

Each diary was coded using a coding scheme specifically developed for this study. For each diary entry, one coder completed the six coding steps outlined in the Appendix. A second coder independently coded 25% of the diaries. Inter-rater reliability was calculated for each of the six coding steps using percentage reliability. For all six coding steps, reliability was 89% or above and ranged from 89% to 97%.

Preliminary Analyses

In order to be included in the final sample, parents were required to complete at least 3 days of observation ($M = 6.18$ days, $SD = 1.21$). Given that the range of days completed varied across parents, all of the data were expressed as a function of the number of days of observation. Preliminary analyses of variance (ANOVA) indicated that there was no main effect of infant gender, and gender did not enter into any significant interaction for any variable. This finding is highly consistent with numerous laboratory-based studies of infant imitation (Hayne *et al*., 2000; Herbert & Hayne, 2000a, b). All of the data were collapsed across gender in the analyses described below.

Most of the behaviours that parents recorded in the diary met our working definition of imitation (see Appendix, coding Step 1). The number of behaviours that did not meet our definition and that were excluded from subsequent analysis did not vary as a function of the infants' age or sibling status ($M = 0.14$ errors, $SE = 0.02$).

Quantity of Behaviour

Our first step was to examine potential age-related and sibling-related differences in the number of behaviours that infants imitated. Each behaviour was assigned to one of three mutually exclusive categories: (1) new behaviours, (2) old behaviours, or (3) repeated behaviours (see Appendix, coding Step 2). There was no main effect of age or sibling status for any of the three categories of behaviour. Overall, parents recorded an average of 3.4 instances of imitation per day. Of these, an average of 1.4 were new behaviours that the infant had never exhibited before.

Quality of Behaviour

Overall, the lack of age-related and sibling-related differences in the total number of behaviours imitated suggests that between the ages of 12 and 18 months, imitation is an equally important mechanism for learning in the real world. Our next step was to determine who and what infants were imitating. Given that we were interested in the infants' ability to learn through imitation, the analyses described below were carried out only on the new behaviours that were contained in the diaries.

Who did infants imitate? To examine who infants imitated, we assigned each new behaviour to one of four mutually exclusive model categories: (1) adult, (2) child, (3) adult/child, or (4) other (see Appendix, coding Step 3). As shown in Figure 1, infants without siblings imitated more behaviours from adult models than did infants with siblings, $F(1, 298) = 60.12$, $p < 0.01$, while infants with siblings imitated more behaviours that were modelled by other children, $F(1, 298) = 136.33$, $p < 0.01$, and modelled by adults and children together, $F(1, 298) = 53.09$, $p < 0.01$, than infants without siblings. In fact, for infants with siblings, approximately half of the actions they imitated were based on actions modelled by other children.

Although most of the behaviours that infants imitated were based on behaviours originally modelled by humans, infants also acquired new behaviours by observing an inanimate object (e.g. television, dishwasher, metronome) or an animal (e.g. eating food off the floor after watching the dog). There was no effect of sibling status on the number of actions imitated from these other models (see Figure 1). Across infants of all ages, the most frequently coded 'other' model was television. This finding is consistent with a small, but growing, body of research demonstrating that infants as young as 15 months will imitate actions seen on television even after a delay (Meltzoff, 1988; Barr & Hayne, 1999).

Are infants explicitly taught to imitate? Recent laboratory studies of imitation have shown that verbal instruction is not necessary for infants to imitate another person's actions; simply presenting the appropriate props is sufficient for imitation to occur (for review see Barr & Hayne, 2000). Given this, we wondered whether infants were provided with explicit instruction to imitate under more naturalistic conditions and, if so, whether instances of explicit instruction varied as a function of the infants' age or sibling status. To address these issues, each instance of imitation was assigned to one of two mutually exclusive categories: (1) spontaneous or (2) taught (see Appendix, coding Step 4).

The number of new behaviours per day that were spontaneously reproduced or explicitly instructed are shown in Figure 2 as a function of age. As shown in Figure 2, there were more instances of spontaneous reproduction than of explicit instruction, $F(1, 294) = 207.77$, $p < 0.01$. Furthermore, although some behaviours were explicitly taught, the frequency of these

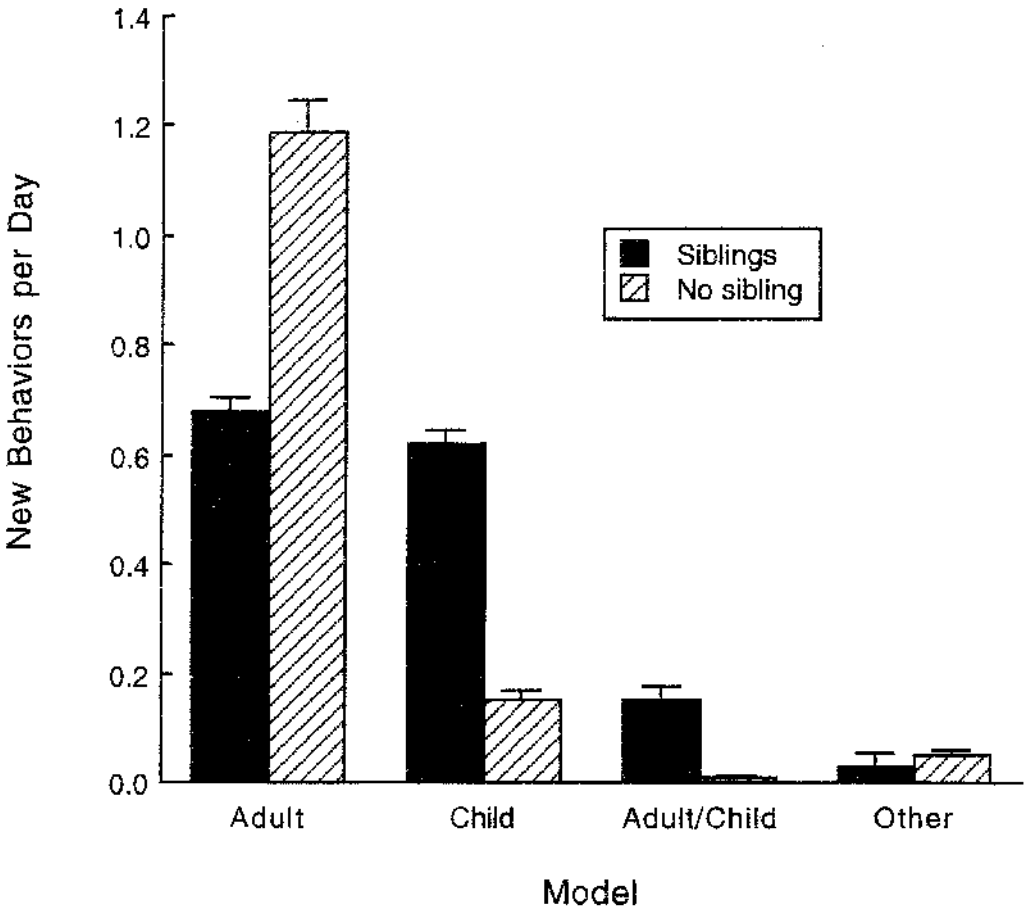

FIG. 1. The mean number (+ 1 SE) of new behaviours per day that infants imitated as a function of the model and sibling status.

behaviours gradually decreased as a function of age, $F(2, 297) = 8.02$, $p < 0.01$ (see right panel).

The number of new behaviours per day that were spontaneously reproduced or explicitly instructed are shown in Figure 3 as a function of sibling status. Infants with siblings were more likely to imitate behaviours spontaneously without explicit instruction than infants without siblings, $F(1, 298) = 8.64$, $p < 0.01$. Conversely, infants without siblings were more likely to receive explicit instruction than infants with siblings, $F(1,298) = 10.89$, $p < 0.01$.

What behaviours did infants imitate? To examine the kinds of behaviours that infants imitated, we assigned each new behaviour to one of three mutually exclusive categories: (1) sounds and gestures, (2) play, or (3) routines (see Appendix, coding Step 5). These data are shown in Figure 4 as a function of sibling status. There was no effect of sibling status on sounds and gestures or routines, but there was an effect of sibling status on play, $F(1, 298) = 6.40$, $p < 0.01$. Overall, infants with siblings imitated more play behaviours than infants without siblings (see Figure 4).

Three factors led us to investigate the play category more closely. First, it has been argued that play is important for the development of human culture, social interaction, language,

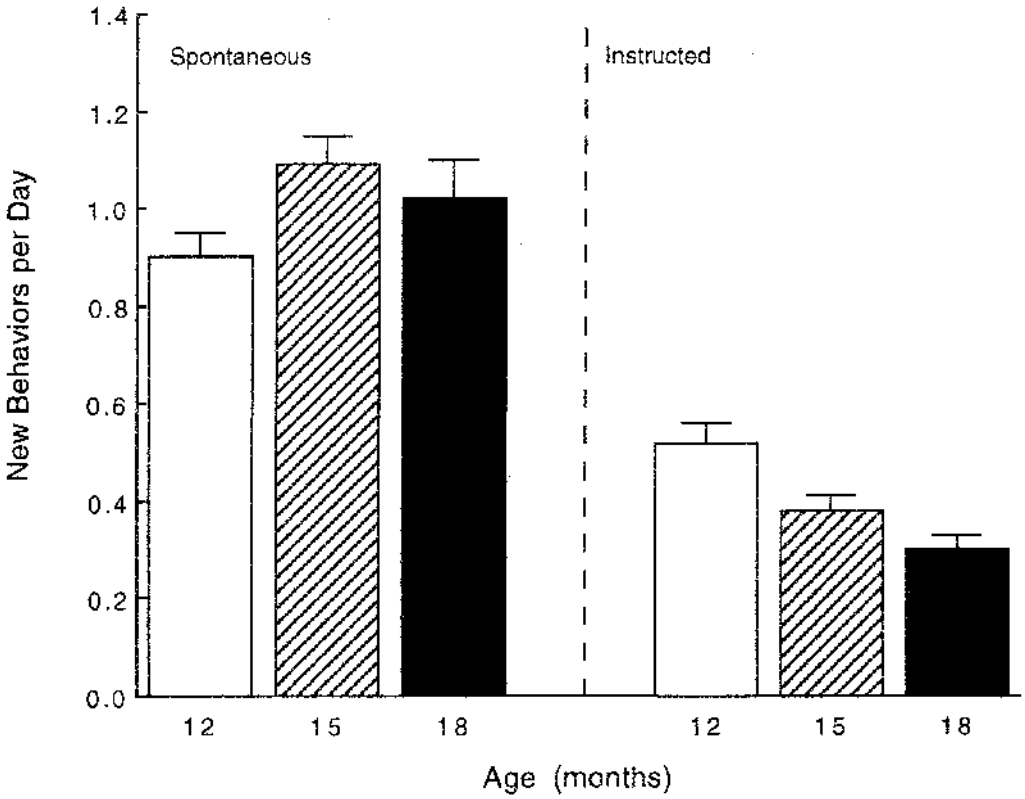

FIG. 2. The mean number (+ 1 SE) of new behaviours per day that infants imitated either spontaneously ('spontaneous') or through explicit instruction ('instructed') as a function of age.

imagination, fantasy, and perspective taking (Piaget, 1962; Garvey, 1977; Fein, 1981; Zukow, 1989). Second, Piaget (1962) argued that play and imitation were complementary processes that followed similar developmental paths. Finally, given that infants with siblings imitated more play behaviours than infants without siblings, we wanted to learn more about the source of these sibling differences.

To do this, each play behaviour was assigned to one of five mutually exclusive categories: (1) rough-and-tumble play, (2) joint pretend play, (3) social interaction play, (4) educational play, or (5) other object play (see Appendix, coding Step 6). There was no effect of age on rough-and-tumble play, joint pretend play, or social interaction play. There was, however, an effect of age on educational play, $F(2, 297) = 3.58$, $p < 0.05$, and on other object play, $F(2, 297) = 6.09$, $p < 0.005$. For both of these play categories, the frequency of these behaviours decreased as a function of age.

Further analysis indicated that there was no effect of sibling status on social interaction play, educational play, or other object play. There was, however, an effect of sibling status on rough-and-tumble play, $F(1, 298) = 4.33$, $p < 0.05$, and on joint pretend play, $F(1, 298) = 5.58$, $p < 0.05$. For both of these play categories, infants with siblings imitated more of these behaviours than infants without siblings.

How do these naturalistic data compare with laboratory-based studies of imitation? Recently, imitation has emerged as a valuable tool for examining age-related changes

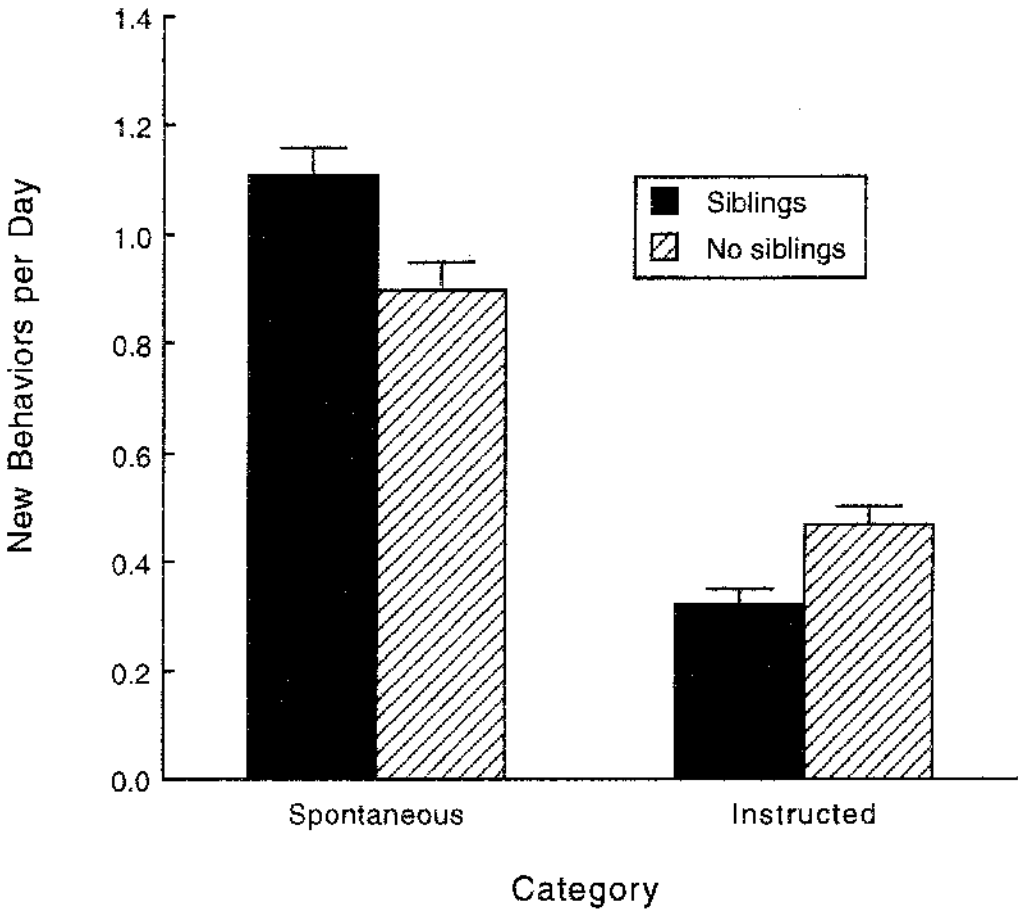

FIG. 3. The mean number (+ 1 SE) of new behaviours per day that infants imitated either spontaneously ('spontaneous') or through explicit instruction ('instructed') as a function of sibling status.

in a number of cognitive processes during the second year of life including learning, memory, and categorisation. Although these studies trace their theoretical roots to observational studies conducted by Piaget, most of the recent research has been conducted under highly controlled laboratory conditions. Both within and across different laboratories, the reliability of these techniques is extremely high, but the lingering question is whether these highly controlled experiments adequately reflect the way in which infants use imitation to acquire new behaviours under more naturalistic conditions.

Two factors that have received considerable attention in laboratory-based research are the imitation of multi-step sequences of behaviour (e.g. McCall *et al*., 1977; Bauer *et al*., 1998), and the substitution of novel objects during re-enactment (e.g. Hayne *et al*., 1997, 2000; Herbert & Hayne, 2000a). These factors played a critical role in Piaget's original theory of the development of imitation and they continue to play an important role in current theories of the development of learning, memory, and mental representation.

To examine age-related and sibling-related changes in these aspects of imitation under naturalistic conditions, we determined the number of new instances of imitation that reflected

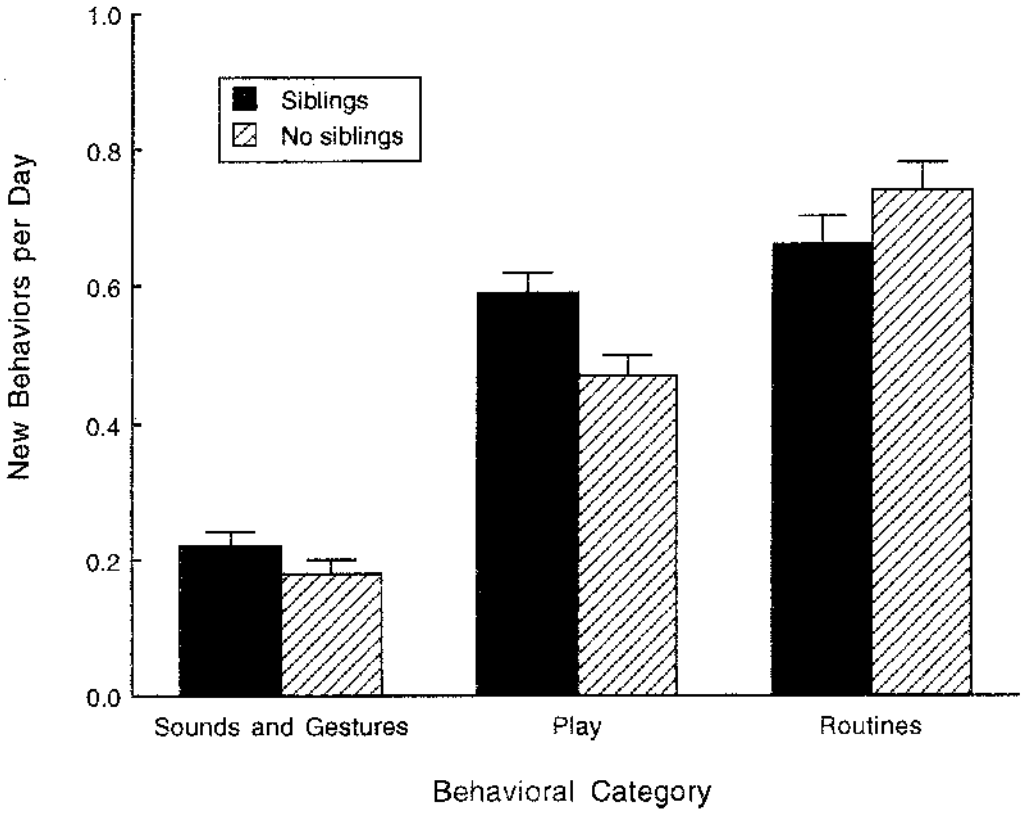

FIG. 4. The mean number (+ 1 SE) of new behaviours per day that infants imitated as a function of sibling status and behaviour category ('sounds and gestures', 'play', or 'routines').

imitation of multi-step sequences and object substitutions during re-enactment, (see Appendix, coding Steps 7 and 8). The number of multi-step sequences that infants imitated and the number of instances in which infants exhibited object substitution during re-enactment is shown in Table II. Consistent with previous laboratory research, infants' imitation of multi-step sequences increased as a function of age, $F(2, 294) = 4.81$, $p < 0.01$, and older infants were more likely to substitute a novel object when reproducing the original target behaviour(s), $F(2, 294) = 5.46$, $p < 0.01$ (see Table II). There were no sibling-related effects for either of these variables.

TABLE II. The mean number of behaviours that infants imitated per day that reflected the reproduction of a multi-step sequence, or that involved an object substitution during re-enactment. The standard errors are shown in parentheses

Age (months)	Multi-step sequences	Object substitution
12	0.16 (0.02)	0.07 (0.01)
15	0.19 (0.02)	0.12 (0.02)
18	0.26 (0.03)	0.15 (0.02)

General Discussion

In the present study, we examined the development of imitation in the course of infants' daily lives. To do this, we asked 300 parents to keep diary records of imitation by their 12-, 15-, and 18-month-old infants. Infants of all ages learned one to two new behaviours each day simply by watching and repeating the actions of others. This finding is particularly remarkable given that, unlike conditions common to the laboratory, the target behaviours in this study were not explicitly directed toward the infant, may or may not have been repeated, and occurred in the presence of a large number of potential distractions. Even under these conditions, infants were able to glean sufficient information from the model to imitate the behaviour(s). Taken together, the present findings confirm that imitation is not an artificial phenomenon, but rather a robust mechanism by which infants learn in the real world.

The diary methodology used in the present experiment provided a number of distinct advantages over standardised laboratory methods for the study of imitation (see also Deutsch, 1994; Wallace *et al*., 1994). First, these parents had considerable opportunity to observe their infant's behaviour and could do so unobtrusively, without disrupting the flow of normal family activity. Second, parents had the opportunity to observe imitation of rare behaviours that may be more difficult to observe under laboratory conditions, as well as the opportunity to observe infants' imitation of a number of different models, including not only siblings, but other family members as well (see also Ashmead & Perlmutter, 1980; Dunn & Kendrick, 1982; Dunn, 1989; Mervis *et al*., 1992). Third, given that an infant's motivation undoubtedly influences whether and when imitation will occur, the present method allowed infants (rather than experimenters) to choose whom, when, and what to imitate.

The first major goal of the present study was to examine age-related differences in imitation within a naturalistic context. Although there were no age-related differences in the number of behaviours that infants learned via imitation, there were age-related differences in the nature of those behaviours. Older infants were more likely to imitate sequences of behaviour that involved multiple steps such as feeding a doll and then putting it to bed, while younger infants were more likely to imitate single actions such as putting a tape into a video recorder, hammering on the wall, or putting sawdust in a fish smoking pan. Similarly, older infants were more likely to use a different object to perform the target actions during re-enactment. For example, a banana, a shoe, or a glasses case were all used in place of a telephone and one infant 'sanded' the walls with a toy block.

The findings that older infants imitated more complex sequences of behaviour and made more object substitutions than younger infants mirror those obtained under more controlled laboratory conditions (e.g. Abravanel *et al*., 1976; McCall *et al*., 1977; Bauer & Hertsgaard, 1993; Bauer *et al*., 1998; Hayne *et al*., 1997, 2000; Herbert & Hayne, 2000a). The similarity between the present findings and those obtained under highly controlled conditions increase the validity of current laboratory-based research on imitation.

The second major goal of the present study was to examine the influence of siblings on learning through imitation. We found that the presence of siblings influenced the quality rather than the quantity of behaviours that infants acquired through imitation. For example, infants with older siblings imitated other children more often than did infants without siblings. In fact, for infants with siblings, approximately 50% of the new behaviours that they imitated were modelled on actions performed by another child. In addition, infants with siblings were more likely than infants without siblings to imitate actions without explicit instruction. In general, 12- to 18-month-old infants were intently interested in older siblings' activities even if they were not directly taught by them (see also Teti *et al*., 1986).

Finally, consistent with observational studies of sibling interactions, parents in the present

study reported that infants with older siblings imitated more rough-and-tumble actions and more pretend actions than infants without siblings (e.g. Baldwin, 1915; Piaget, 1962; Lamb, 1978a, b; Abramovitch *et al*., 1979). For example, one brother and sister turned pots upside down and climbed between them using them as 'stepping stones' across the room. Other siblings played 'shopping' with baskets and soap, or crawled around the floor and ate like the cat. Others 'parked' their bikes, or 'read' to their teddies on chairs. Sibling play was also more likely to include playing chase, follow the leader, jumping, climbing (one infant copied her older sister and stepped off the bed onto a bedside table to pull curtains), play fighting and rolling on the floor.

The increased imitation of joint pretend play exhibited by infants with older siblings may have important implications for individual differences in cognitive development. It has been argued that joint pretend play fosters the skills required for problem solving, creativity, planning, and negotiation (Garvey, 1977, 1990; Bretherton, 1984; Bretherton *et al*., 1984; Miller & Garvey, 1984). Furthermore, it has also been argued that joint pretend play might be a precursor to event schemas or scripts that are used later in narratives and autobiographical memory (Bretherton *et al*., 1984; Nelson & Seidman, 1984).

Recently, Perner and colleagues (Perner *et al*., 1994; Ruffman *et al*., 1998) have argued that joint pretend play with older siblings may also play a particularly important role in the development of theory of mind. In their studies, 3- to 4-year-old children with older siblings passed a standard false belief task at an earlier age than children without siblings. The authors hypothesise that sibling interaction provides a rich source of information about mental representation that facilitates a child's understanding of 'other minds' (see also Call & Carpenter, 2002; Dunn, 1989; Garvey, 1990; Meltzoff & Gopnik, 1993). Speculatively, the present findings raise the possibility that the effect of older siblings on the emergence of theory of mind may begin in the context of imitation of joint pretend play.

In the present study, infants learned new behaviours through imitation that had special cultural significance. For example, infants imitated behaviours that are unique to the New Zealand Māori culture including the *haka* (war dance/challenge) and swinging a *poi* (an object used in a ceremonial dance). Infants also imitated behaviours from the Päkehä or Western European culture including the gesture of shaking hands and clinking glasses together (the 'cheers' gesture). Collection of additional diary data would add to our current understanding of the role that imitation plays in the transmission of culture (Tomasello *et al*., 1993). In the same vein, the degree to which older siblings also play a role in infant imitation in other cultures is not known. Cross-cultural differences in the level of social responsibility that siblings are assigned, for example, might alter the degree to which infants imitate their actions or the nature of the behaviours that they imitate (Ervin-Tripp, 1989; Watson-Gegeo & Gegeo, 1989; Zukow, 1989). Much of current popular culture is also presented via the media. The role of television in early infant education and its effect on cultural transmission via imitation has been limited to only a handful of empirical studies (e.g. McCall *et al*., 1977; Meltzoff, 1988; Barr & Hayne, 1999). The present findings demonstrate that infants spontaneously begin imitating actions from television during the second year of life and suggest that this area warrants further investigation.

Finally, despite the fact that the infants who participated in the present study had little or no childcare experience, the present findings may have important implications for early childcare settings. For example, older peers in childcare might act as surrogate siblings enriching imitation (and other aspects of cognitive development) in much the same way that older siblings do. In mixed age groups, for example, younger members of the childcare community may enjoy precocious initiation into the world of joint pretend play through imitation of their older counterparts. It is well recognised that children with extensive

experience in high-quality childcare typically excel on measures of cognitive and language development (Burchinal *et al*., 2000). The implicit assumption here has always been that these intellectual gains are the result of high-quality adult–child interactions (e.g. Smith, 1999). The present findings suggest that high-quality child–child interactions may be equally important. In mixed age groups, for example, younger children have numerous opportunities to observe and imitate the actions of their older and more sophisticated peers. The results of the present experiment suggest that these opportunities may facilitate subsequent cognitive development. In our view, the importance of imitation in infant development should be stressed not only to parents, but to early childhood educators as well.

In conclusion, the results of the present study are consistent with Piaget's (1962) theory—the emergence of imitation is a robust phenomenon and occurs without the favourable input of older siblings. Consistent with Vygotsky's theory, however, imitation by infants with and without older siblings differed as a function of the social environment and led to differential development of imitation skills (for the same argument regarding language skills, see Deutsch *et al*., 1997). It is such a combination of a robust phenomenon and situational factors that often leads to a pattern of individual variation (Deutsch *et al*., 1997).

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Appendix

Each diary entry was coding using the scheme outlined below.

Step 1: errors: imitation or not

Imitation was defined as a non-verbal behaviour learned by observation from another's actions. The behaviour could be reproduced either exactly or approximately, immediately or after a delay. Furthermore, the behaviour could be either novel or familiar to the infant. For each entry in the diary, the coder first established whether or not the behaviour met the working definition of imitation. In addition, the following behaviours were also eliminated from further analysis:

- Words were not counted unless they are parts of songs or other routines (e.g. '1, 2, 3' or 'this little piggy …'). Imitation of new words was not included.
- Behaviours were excluded if the parent has written 'himself', 'herself', or 'none' in the model section or if the model section was blank.

Step 2: new, old, or repeated behaviours

Each behaviour that met the working definition of imitation was assigned to one of three mutually exclusive categories. Behaviours were assigned to the 'new' and 'old' category on the basis of the information contained in column 5 of the diary, labelled 'new?'. Behaviours were assigned to the 'repeated' category if the infant repeated an old or new behaviour on subsequent days of recording.

Step 3: who did infants imitate?

For each diary entry, the coder determined whether the infant imitated an action modelled by an adult (e.g. mother), child (e.g. sibling), adult/child (e.g. mother and sibling), or some other, non-human (e.g. television, cat) model on the basis of the information provided in column 2 of the diary, labelled 'model'.

- Adult models included parents, relatives, adult friends, teachers, etc.
- Child models included anyone under 17 years of age (age of child was noted under the model's name, e.g. brother 6 years).
- Adult/child models included family interactions or mother/sibling/infant interaction.
- Other models included non-human animals and inanimate objects (e.g. television, metronome, dishwasher).

Step 4: spontaneous imitation or explicit instruction?

For each behaviour, parents indicated whether infants imitated the behaviour spontaneously in the absence of explicit instruction. In some instances, parents did not indicate whether or not the behaviours had been taught. These behaviours were eliminated from analyses involving this variable.

Step 5: what kinds of behaviour did infants imitate?

Each behaviour was assigned to one of three mutually exclusive categories:

- The 'sounds and gestures' category included actions such as waving, clapping, pointing, stamping feet, and snapping fingers; socially conventional behaviours, such as placing a hand over the mouth when coughing or yawning or blowing on hot food; communicative gestures and sounds, such as winking, blowing kisses, sign language, high five; and cultural gestures such as the handshake, bowing to another person and the Mäori war dance, the *haka*.
- The 'play' category included physical activity, such as riding a bike, educational games such as reading books or doing puzzles, social interactional games such as 'peek-a-boo', and joint pretend play, such as using a kitchen cupboard as a car.
- The 'routine' category included general household routines such as cleaning, mealtime routines, raking leaves, carrying firewood, using the remote controls, answering the telephone, pulling curtains, feeding the pets, painting, and hammering. It also included adult routines which infants see adults engage in but are not engaged in by infants, such as reading the paper, shaving, putting on make-up, 'driving a car', putting on glasses, and child routines which involved any behaviour involved in the child's personal hygiene or safety as well as in getting dressed and undressed.

Step 6: play categorisation

Each of the behaviours that had been assigned to the *play* category (see coding Step 5) were assigned to one of five mutually exclusive categories:

- *Physical activity/rough-and-tumble play*: play behaviours were assigned to this category if they involved simple repetitive gross motor activity, with or without an object, and with or without others (e.g. banging pot lids, throwing balls, jumping on trampolines, climbing, splashing in water, dancing, or riding a bike). In general, these behaviours were defined as behaviours that the infant engaged in with adults or children, were boisterous, unruly, involved gross motor activity, may have involved physical contact and may have been accompanied by positive emotion. Behaviours in this category met the definition of functional play (Smilansky, 1968), practice play (Piaget, 1962), or rough-and-tumble play (Blurton Jones, 1967).
- *Joint pretend play*: play behaviours were assigned to this category if and only if the model's behaviour reflected pretend play. For example, if the child put her doll in a cradle after watching her mother put a real baby in a cot [crib], this behaviour was coded as object substitution, but it was not considered to involve imitation of a pretend action. If, however, the child put her doll in a cradle after watching her mother put another doll in a cradle, then this behaviour was coded as imitation of a pretend action.
- *Cognitive/creative/educational play*: play behaviours were assigned to this category if the infant imitated an action with an object that was designed for educational and learning purposes (e.g. ring stackers, object sorters, puzzles, drawing and painting, books, musical instruments, board games).
- *Social interaction play*: play behaviours assigned to this category included social interaction songs and games that an infant engaged in with other adults or children which often involved scripted actions, such as peek-a-boo, pat-a-cake, this little piggy, I'm a little teapot, twinkle twinkle little star, ring-a-ring-o-rosies, where is my nose, eyes, etc.?
- *Other object play*: any play behaviour that could not be coded into one of the four categories described above was assigned to this category.

Step 7: multi-step sequence

Each instance of imitation was coded as either a single-step action or a multi-step sequence. An example of a single-step action was hammering with a wooden toy hammer; an example of a multi-step sequence was pulling a chair over to the kitchen bench (counter), putting a tea bag in a cup, and bread in the toaster.

Step 8: object substitution

For each instance of imitation, the coder determined whether the behaviour was *object directed*. For each imitative behaviour involving an object, the coder also determined whether the infant used the original object when they imitated the behaviour(s) or substituted another, similar object. For example, if the child strummed a toy tennis racquet after watching his father play the banjo, this behaviour was coded as an object substitution.