

Mark Nielsen · Emma Collier-Baker ·
Joanne M. Davis · Thomas Suddendorf

Imitation recognition in a captive chimpanzee (*Pan troglodytes*)

Received: 9 March 2004 / Revised: 18 June 2004 / Accepted: 22 July 2004 / Published online: 21 August 2004
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Abstract This study investigated the ability of a captive chimpanzee (*Pan troglodytes*) to recognise when he is being imitated. In the experimental condition of test 1a, an experimenter imitated the postures and behaviours of the chimpanzee as they were being displayed. In three control conditions the same experimenter exhibited (1) actions that were contingent on, but different from, the actions of the chimpanzee, (2) actions that were not contingent on, and different from, the actions of the chimpanzee, or (3) no action at all. The chimpanzee showed more “testing” sequences (i.e., systematically varying his actions while oriented to the imitating experimenter) and more repetitive behaviour when he was being imitated, than when he was not. This finding was replicated 4 months later in test 1b. When the experimenter repeated the same actions she displayed in the experimental condition of test 1a back to the chimpanzee in test 2, these actions now did not elicit those same testing sequences or repetitive behaviours. However, a live imitation condition did. Together these results provide the first evidence of imitation recognition in a nonhuman animal.

Keywords Chimpanzee · Imitation · Imitation recognition

Introduction

Over the last decade, similarities and differences have been established in the way human children and chimpanzees engage in imitation (e.g., Carpenter et al. 1995; Nagell et al. 1993; Tomasello et al. 1993; Whiten et al. 1996). In this paper, we use the term “imitation” to refer very broadly to instances where individuals reproduce actions or behaviours they have witnessed being

produced by another (i.e., copying). Developmental psychologists have also begun to study the ability of human children to recognise when they themselves are being imitated by others, and this ability, along with the ability to imitate, has become recognised as an important aspect of early social communication (Asendorpf et al. 1996; Meltzoff 1990; Meltzoff and Decety 2003; Nadel 2002; Nielsen and Dissanayake 2004). In contrast, despite a large literature on imitation in chimpanzees, there are no experiments investigating imitation recognition (Suddendorf and Whiten 2001). This is the subject of the present study.

In response to being imitated, infants in their second year tend to repeat the particular gesture that is being imitated and engage in “testing” behaviour (i.e., systematically varying activity while closely watching the imitating adult¹) to see if their behaviour will continue to be copied (Meltzoff 1990; Meltzoff and Decety 2003). Asendorpf et al. (1996) studied imitation recognition in 18-month-old infants by having a sole adult closely imitate all of an infant’s activities and postures while sitting opposite him or her. In response to being imitated in this way, over half (57%) of the 76 infants in this study showed the kind of “testing” behaviour that the authors interpret as evidence for imitation recognition (Asendorpf et al. 1996; Meltzoff and Decety 2003). We adopted this paradigm to investigate whether a chimpanzee would behave similarly when he was being imitated.

Methods

Subject and housing conditions

The subject in this study was a male captive-born chimpanzee (*Pan troglodytes*), Cassie, aged 31 years. Cassie is housed with his 27-year-old half-brother, Ockie,

M. Nielsen (✉) · E. Collier-Baker · J. M. Davis · T. Suddendorf
Early Cognitive Development Unit, School of Psychology,
University of Queensland,
Brisbane, QLD, 4072, Australia
e-mail: nielsen@psy.uq.edu.au
Tel.: +61-7-33469643
Fax: +61-7-33654466

¹ A humorous example of the Marx Brothers showing this type of behaviour can be viewed at: <http://xroads.virginia.edu/~MA01/Cober/marx/mirrormovie.html>.

at Rockhampton Botanical and Zoological Gardens (Oekie would not sit with the experimenter for this study and hence could not be tested). Cassie was tested in his enclosure with no interruptions to his daily routine, feed or water. The enclosure comprises one large outdoor area (20 m in length, 10 m in width and 4 m in height) and two smaller indoor areas (both 2 m in length, 4 m in width and 4 m in height), one of which functions as a holding pen (e.g. for when the main enclosure is being cleaned). Cassie had previously participated in only one other study (Collier-Baker et al., unpublished data) and that study did not involve imitation.

Procedure

During testing, Cassie was in one of the indoor pens and at no time did Oekie interfere with testing. Three tests of imitation recognition were conducted. Test 1b was a replication of test 1a. Test 1b and test 2 were conducted 4 months after test 1a.

The experimenter (E.C.B., who had frequently interacted with Cassie) sat directly opposite the chimpanzee, separated by the wire mesh of the enclosure. A camera was positioned over the shoulders of the experimenter to capture only the behaviour of the chimpanzee for independent coding from video. A second camera taped both the experimenter and the chimpanzee.

Test 1

The experimenter imitated the chimpanzee or performed one of three control actions. The conditions were presented in three continuous blocks of four trials each, the latter following an ABBA design (Table 1). Each trial lasted 30 s, and a 10 s transition period was interposed between each trial. During this inter-trial interval the experimenter sat motionless. To test the reliability of the results, test 1b was identical to, and conducted 4 months after, test 1a. The four conditions in both tests are the following.

Test condition: imitation The experimenter replicated all movements and body postures of the chimpanzee as he exhibited them. That is, the experimenter's actions were temporally and spatially contingent on the behaviour of the subject and were intended to match his behaviour as exactly as possible. The experimenter's actions were performed ipsilateral to the chimpanzee's. In this sense, the experimenter acted like a "mirror" to the subject.

Control condition 1: contingent non-matching The experimenter produced impromptu actions that were temporally contingent on the chimpanzee's behaviour, but were distinct from the actions he produced. That is, the experimenter moved only when the subject moved, but her actions did not match those of the chimpanzee. For example, if the chimpanzee raised his foot the experimenter might have touched her head with her hand. This control was designed to establish whether mere contingency of behaviour would elicit similar responses to the test condition.

Control condition 2: non-contingent non-matching While oriented to the chimpanzee the experimenter was instructed to produce a sequence of actions of her own volition that were temporally and spatially unrelated to the chimpanzee's actions. This was to control for the possibility that mere movement of the experimenter would result in the chimpanzee showing similar behaviours to those shown in the test condition.

Control condition 3: no action The experimenter remained still and did not produce any actions. This control assessed whether the behaviours shown by the chimpanzee in the test condition would also be exhibited if the experimenter remained motionless.

Test 2

Test 2 was designed to control for the possibility that there might be something inadvertently peculiar about the imitation displayed by the experimenter during the experimental conditions of test 1 that might cause Cassie

Table 1 Order of conditions for test 1a and 1b and for test 2 on chimpanzee Cassie (*Pan troglodytes*)

Block 1		Block 2		Block 3	
Trial number	Condition	Trial number	Condition	Trial number	Condition
Test 1a and 1b					
1	Imitation 1	5	Non-contingent non-matching 1	9	Imitation 5
2	Contingent non-matching 1	6	Imitation 3	10	No action 1
3	Contingent non-matching 2	7	Imitation 4	11	No action 2
4	Imitation 2	8	Non-contingent non-matching 2	12	Imitation 6
Test 2					
1	Prior imitation 1	5	Imitation 3	9	Prior imitation 5
2	Imitation 1	6	Prior imitation 3	10	Imitation 5
3	Imitation 2	7	Prior imitation 4	11	Imitation 6
4	Prior imitation 2	8	Imitation 4	12	Prior imitation 6

to behave differently to the control conditions. To assess this, in test 2 the experimenter studied and then repeated back to Cassie the exact same behaviours she performed in the experimental imitation condition of test 1a. Except, of course, that now these actions were not contingent on Cassie's immediate behaviour. Test 2 was conducted 4 months after test 1a and immediately prior to test 1b.

Cassie was exposed to two different conditions (imitation and prior imitation) using a repeated ABBA design (Table 1). Each trial lasted 30 s with a 10 s transition period interposed between each trial. The two conditions are the following.

Test condition: imitation Following the procedure for the experimental imitation condition in test 1, the experimenter replicated all movements and body postures of the chimpanzee as he exhibited them.

Control condition: prior imitation Before testing, the experimenter (E.C.B.) reviewed the videotape of her behaviour recorded during test 1a and rehearsed all of the movements she produced in each imitation trial (see Appendix 1 for a list of the relevant actions). She then reproduced these actions in each of the corresponding prior imitation trials of the present study. For example, in the first prior imitation trial of the present study the experimenter replicated the same behaviours and actions she had exhibited during the first imitation trial in test 1a. A second experimenter used transcriptions of E.C.B.'s behaviour taken from the video to prompt her throughout the prior imitation trials.

Data analysis

For each trial, the subject's behaviour was coded from videotape for the absence or presence of a testing sequence and for the total duration of sequences of behaviour repetition. Following Asendorpf et al. (1996), to be coded as a testing sequence the behaviour had to be comprised of (1) at least four successive, different activities, (2) at least 5 s orientation to the experimenter, and (3) a minimum length of 10 s for the whole sequence. To be classified as behaviour repetition the subject, whilst oriented to the experimenter, had to (1) perform the same action at least four times, (2) without exhibiting an alternative action, and (3) without stopping the repeated action for any longer than 3 s.

Reliability

The first author was the primary coder of all measures. A second coder who was blind to the specific hypotheses and conditions of the study independently observed and coded the videotape of the first testing session (test 1a). An intraclass correlation (Shrout and Fleiss 1979) indicated that there was good agreement between coders on the duration of time spent engaged in behaviour repetition

($r=0.93$, $df=12$, $p<0.001$). Only one testing sequence was exhibited by the chimpanzee in test 1a. This testing sequence was identified by both coders.

Results

Test 1a

Testing sequences

As previously noted, the chimpanzee engaged in only one testing sequence. During the fifth imitation trial (block 3, trial 9) Cassie, while oriented to the experimenter, placed the back of his hand to the cage, rotated his arm clockwise, poked his finger out of the cage, placed the back of his hand to a different part of the cage, rotated his arm a second time then again placed the back of his hand to the cage. This series of actions had not been seen either previously or in any form during the other test trials.

Behaviour repetition

The total duration of time spent engaged in behaviour repetition is presented in Fig. 1. Cassie spent much of the imitation test trials engaged in repetitive actions. In contrast, little repetitive behaviour was exhibited in any of the control conditions. An ANOVA revealed that the duration of behaviour repetition was different across conditions, $F=11.80$, $df=3,8$, $p=0.003$. Post hoc comparisons using the Tukey HSD test showed that the duration of behaviour repetition in the imitation trials was significantly longer than the duration of behaviour repetition in the contingent non-matching ($p=0.033$), non-contingent non-matching ($p=0.009$) and no action ($p=0.009$) trials. The duration of behaviour repetition exhibited during the contingent non-matching trials was not different from the duration in either the non-contingent non-matching ($p=0.854$) or the no action ($p=0.854$) trials. The duration of behaviour repetition exhibited during the non-contingent non-matching trials was also not different from the duration in the no action trial ($p=1.000$).

Test 1b

The chimpanzee was attentive throughout testing. The only exception was that following administration of the first no movement control trial, Cassie moved away from the experimenter and could not be coaxed back. Therefore, no data was collected for the second no action control trial or the final imitation trial.

Testing sequences

Cassie engaged in two testing sequences. As with test 1a, these testing sequences only occurred in the imitation

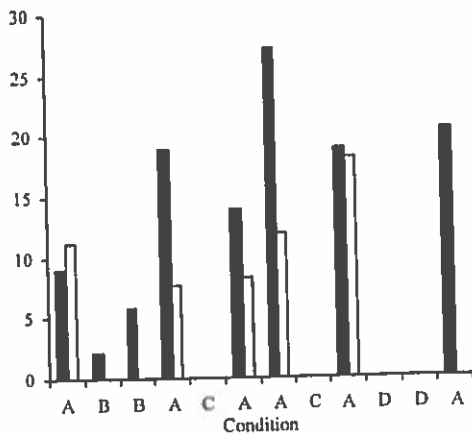


Fig. 1 Total duration of time (seconds) spent by chimpanzee Cassie (*Pan troglodytes*) engaged in behaviour repetition across all conditions (A: Imitation; B: Contingent Non-Matching; C: Non-Contingent Non-Matching; D: No Action) of test 1a (filled columns) and 1b (open columns). Note: no data was collected for the second D: No Action Control trial or the final A: Imitation trial of test 1b

condition. In the third imitation trial (block 2, trial 6), while carefully monitoring the experimenter, Cassie poked his finger out of the cage, wiped the ground in front of him, picked up a piece of straw and placed it in his mouth, pressed his mouth to the cage, then poked his finger out of the cage again. In the fifth imitation trial (block 3, trial 9), again while carefully monitoring the experimenter, Cassie put his lips to the cage, clapped his hands, hit the ground in front of him then moved his head from left to right and back again. These series of actions had not been seen either previously or in any form during the other test trials.

Behaviour repetition

The total duration of time spent engaged in repetitive behaviour is presented in Fig. 1. Cassie spent approximately one-third of the imitation trials engaged in repetitive actions, but exhibited no repetitive behaviour in any of the control conditions. The mean duration of repetitive behaviour exhibited in the imitation test trials of test 1b was not significantly different from test 1a, $t=1.93$, $df=4$, $p=0.126$. The results obtained here thus replicate those obtained in test 1a.

Test 2

Testing sequences

The chimpanzee engaged in three distinct testing sequences (B1, trial 2; B2, trial 5; B2, trial 8). For example, in the fourth imitation trial (block 2, trial 8), while watching the experimenter Cassie hit the ground to his left and then to his right, placed his arm to the back of the cage, pursed his lips, touched the cage, hit the ground in front of him, nodded his head, then placed the back of

his arm to the cage. As with the testing sequences exhibited in test 1a and 1b, this sequence of actions had not been seen before.

Behaviour repetition

The total duration of time spent engaged in behaviour repetition is presented in Fig. 2. As with tests 1a and 1b, the chimpanzee spent the majority of the imitation trials engaged in repetitive actions. He did not exhibit any repetitive behaviour in any of the prior imitation trials. The repetitive behaviour exhibited in the prior imitation trials of test 2 was significantly less than the repetitive behaviour exhibited in the imitation trials of test 1a where the experimenter displayed the same behaviour, $t=7.21$, $df=5$, $p=0.001$.

Discussion

In response to being imitated by an experimenter a captive chimpanzee exhibited distinct testing sequences and engaged in extended bouts of repetitive behaviour. It is unlikely that the chimpanzee exhibited these behaviours only because of the presence of the experimenter. Neither testing sequences nor repetitive behaviours were evident when the experimenter sat motionless in front of the chimpanzee (test 1, control condition 3). These behaviours were also not shown when the experimenter moved randomly (control condition 2) and hence it is also unlikely that they were made solely in response to the experimenter moving. When the experimenter moved contingently but did not imitate the chimpanzee (control condition 1), some repetitive behaviour was evident in test 1a. However, the duration of this repetitive behaviour was significantly less than when the chimpanzee was being imitated and no such behaviour was exhibited during the same control condition in test 1b. Thus, recognising the contingency between his own movements and those of the experimenter cannot alone account for Cassie's behaviour

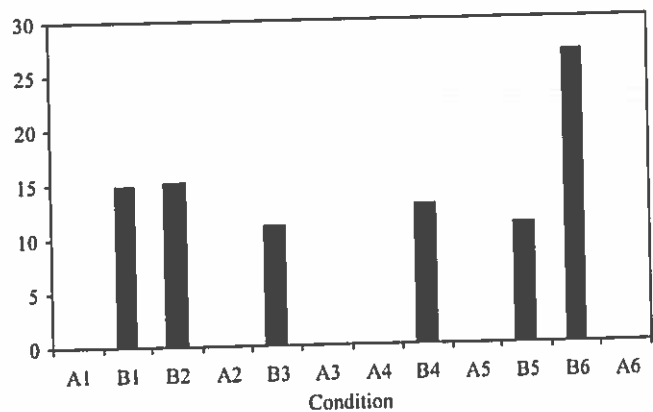


Fig. 2 Total duration of time (seconds) spent by chimpanzee Cassie (*Pan troglodytes*) engaged in behaviour repetition during test 2 (A: Prior Imitation; B: Imitation)

when he was being imitated. Finally, when the actions in test 1a that had elicited testing sequences and repetitive actions were repeated back to the chimpanzee in test 2 he did not show either behaviour. The most likely conclusion, therefore, is that in the experimental conditions the chimpanzee recognised the correspondence between his actions and those of the imitating adult. At some level, he recognised being imitated.

In six different instances, the chimpanzee systematically varied his activity while monitoring the reactions of the experimenter. In each instance the experimenter was directly copying his behaviour. The chimpanzee did not show this behaviour when he was not being imitated nor had it been witnessed in previous interactions with him. In developmental psychology, such "testing" behaviour is regarded as the most convincing evidence for imitation recognition (Asendorpf et al. 1996; Meltzoff 1990). In response to being imitated, young children also tend to repeat the particular gestures being copied (Meltzoff and Decety 2003); so did Cassie. Thus, the responses of the captive chimpanzee to being imitated were similar to the responses of young human children.

The current research thus adds to literature that has identified a cluster of accomplishments, such as mirror self-recognition, means-ends reasoning, and invisible displacement understanding, shared by the great apes and 18 to 24-month-old human children (see Suddendorf and Whiten 2001 for a review). Suddendorf and Whiten (2001) argued that the same representational skill (secondary representation, Perner 1991) underlies these behaviours in both children and great apes. They thus predicted that the great apes, like children, should be capable of recognising when they are being imitated. The studies reported here support this prediction. Additional research is now needed to investigate the nature and range of imitation recognition in chimpanzees and other animals, and how closely associated this ability is with the ability to imitate others.

Acknowledgements A University of Queensland Early Career Research Grant (122524853) to M.N. and an Australian Research Council Discovery Grant (DP0208300) to T.S. funded the work described in this article. We also wish to acknowledge the kind cooperation of the staff of the Rockhampton Botanical and Zoological Gardens. These experiments comply with the current laws of Australia regarding the use of animals in research.

Appendix 1

Table 2

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Table 2 The actions exhibited by the chimpanzee in test 1a and subsequently by the experimenter during each prior imitation trial of test 2

Trial	Actions	Frequency
(Prior) Imitation 1	Poke finger out of cage	5
	Nod head	3
	Place finger on cage	1
	Raise arm	1
	Hit ground	10
	Wipe nose	1
	Tap ground	1
	Wipe forehead	1
(Prior) Imitation 2	Poke finger out of cage	15
	Poke finger out of cage	2
	Nod head	2
(Prior) Imitation 3	Poke finger out of cage	13
	Touch teeth	1
	Open mouth	1
	Place hand on cage	2
(Prior) Imitation 4	Clap hands twice while lying on back	9
	Wipe eyebrows	1
	Clap hands twice while lying on back	5
(Prior) Imitation 5	Poke finger out of cage	3
	Grab cage	1
	Place back of hand to cage	1
	Rotate arm	1
	Poke finger out of cage	1
	Place back of hand to cage	1
	Rotate arm	1
	Place back of hand to cage	22
(Prior) Imitation 6	Poke finger out of cage	4
	Wipe head	1
	Place back of hand to cage	3
	Poke finger out of cage	9

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