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Does the Experimenter's Handedness Influence an Infant's Hand Preference for Grasping?

Fagard J*, Potdevin D and Margules S

Laboratoire Psychologie de la Perception (UMR 8242), CNRS-Université Paris Descartes, Paris, France

***Corresponding Author:** Jacqueline Fagard, Laboratoire Psychologie de la Perception (UMR 8242), CNRS-Université Paris Descartes, Paris, France, E-mail: jacqueline.fagard@gmail.com

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Abstract

In this paper we investigated the effect of the experimenter's handedness on infants' choice of what hand to use in a handedness test. We divided forty-eight 12-month-old infants into four groups, depending on the experimenter's handedness (right-handed or left-handed) and the condition (experimenter writing or not writing). The results show that when the experimenter wrote, the infants were significantly less likely to use their right hand alone to grasp objects than infants in the no writing condition, resulting in a significantly lower handedness index. However, the effect on handedness index was the same independently of the experimenter's handedness. These results are discussed in terms of attentional factors and motor resonance influencing infants' choice of hand during a handedness test.

Keywords: Handedness; Infants; Motor resonance; Experimenter's handedness

Introduction

Handedness has been shown to start as early as in utero, when fetuses suck their right thumb more than their left at 15 weeks of gestation [1]. Although this early manual lateralization seems to be predictive of later handedness [2], the age at which infants' handedness is comparable to that of adults remains unclear. As soon as infants start grasping objects, most do so more with their right hand than with their left [3-6]. However, the percentage of non-lateralized infants is often found to be larger than the percentage of left- and even of right-handers, in any case much larger than in adults [7-9]. Moreover, at the individual level, handedness goes through many fluctuations during the first months of grasping [7,8,10,11] at least in the majority of infants [12]. If handedness is neither strong nor stable in early childhood, it should be particularly sensitive to factors influencing its manifestation, such as spatial configuration, object size, experimenter's handedness, etc. The hand used for object grasping has indeed been shown to be very sensitive to object and task characteristics, such as precision grip [10], object size [13], and object spatial position [14]. The goal of the study presented here was to study the influence of another factor likely to affect the infant's choice of hand to grasp an object during a handedness test: namely, the experimenter's own handedness.

At least three studies have shown that adults' handedness influences infants' choice of hand to manipulate toys in a one-to-one situation. The first two reported that infants' tended to match their mother's choice of hand when playing with her, and that this matching tendency increased from 7 to 11 months of age [15-17]. In the third study, 24 infants aged 12 to 15 months were tested on five new actions demonstrated either by a right-handed experimenter or by a left-handed one. The infants were either seated in front of the experimenter making the demonstration (opposite condition) or on the experimenter's lap: the opposite-condition group saw the demonstration from across the table (other's point of view) whereas the lap-condition infants saw the demonstration from their own point of view. After the left-handed experimenter demonstrated the actions, none of the infants consistently used a right-handed strategy to manipulate the objects, regardless of the condition (opposite *vs.* lap), even though most infants had used their right hand when first grasping the objects [18]. This shows the influence of seeing an action on the organization of an infant's own action, and that this influence is similar whether they see the action from the actor's own point of view or from another's point of view. The fact that seeing the experimenter use her left hand the front biases the infant toward more use of his own left hand shows that infants tend to imitate the hand used by the experimenter anatomically, even when the anatomically corresponding hands are not spatially aligned.

The influence of the experimenter's handedness on the infant's choice of hand is one example of the importance of observational learning in development. It is known than some imitation can be observed from birth, for instance for mouth opening, and that as early as 6 months infants can imitate repeated manual actions an adult makes in front of him, such as squeezing a duck [19]. True observational learning appears during the second year [20,21]. In daily life, infants have many

opportunities to observe others performing actions and they are influenced by how these actions are performed. For instance, observational learning in the absence of explicit demonstration has been shown experimentally to accelerate learning of how to use a tool to grasp an out-of-reach object [22]. When testing infants' handedness for reaching and grasping, it is possible that the experimenters' handedness influences the infant's choice of hand. Experimenters are usually careful not to use the same hand to give all objects to the infant. Typically, they either offer the objects with both hands, or alternate between the two. But are they always careful not to provide any cues to their handedness? For instance, do they take the same precaution when they reach for the object, or when they write down which hand the infant grasped with, which they might have to do sometimes? Similarly, even when the experimenter gives only an indirect clue to her handedness, this might influence infants' choice of hand for grasping. To our knowledge, no study has systematically investigated this influence of the experimenter's right-versus left-hand preference on infants' choice of which hand to use in grasping an object during a test of unimanual handedness.

We thus decided to test the effect of the experimenter's handedness on infants' choice of hand when grasping objects. In one condition, the experimenter was careful not to provide any clues to her own handedness to the infant. In the other condition, the experimenter used her preferred hand, not to give the object to the infant, but immediately afterward when using a pencil to check off which hand the infant had used. We compared the two conditions with a right-handed and left-handed experimenter. We hypothesized that infants' choice of hand for grasping would not be influenced by the experimenter's handedness when she carefully avoided giving any cues to it, but that it would matter when she used a pencil to note the infant's hand selection. We decided to test infants at 12 months, an age when hand preference for grasping is a good predictor of later handedness [23].

Method

Participants

Forty-eight infants were tested in our baby lab. They were 12-months-old (Mean=368 days [Range: 352-384]; 24 girls). The infants had been born full-term and were free of neurological disorders. Parental consent was granted before observing the infants. We also recorded parents' handedness.

Procedure and materials

Tests of handedness for infants: All children were given a classical handedness test. The baby handedness test (BbHtest) comprises 15 items [3]. The objects used were small baby toys, between 0.5 and 7 cm wide and between 2 and 17 cm high. We avoided objects inviting bimanual manipulation, such as objects with a separately mobile part, since in this case, the infant may grasp the object with the non-preferred hand in anticipation of using the preferred hand for the more active part of the action. The order of presentation was random. All objects were presented on the table along the midline within reaching distance of the infant, and handed to the infant by the experimenter using her two hands. After a few minutes, the experimenter used her two hands to gently take the object from the infant, and the next object was presented. All infants were tested in the same room in our babylab, and were seated on their parents' lap during the whole test session, which lasted no more than 15 minutes. A videocamera recorded all sessions.

There were two experimenter handedness groups: 24 infants were tested by an experimenter who is right-handed (for writing), whereas 24 infants were tested by an experimenter who is left-handed (for writing). Both experimenters were women. Within each of these groups, for half of the children the experimenter used her own preferred hand to tick off the hand the child had used with a pencil (writing condition). The checklist was placed in front of the experimenter's preferred hand. For the other 12 infants in each group, the experimenter did not write at all (no writing condition). The videocamera used to record the session was placed in the same location and position behind the experimenter in both the writing and no writing conditions. The infants were randomly assigned to one of the four groups: right- or left-handed experimenter, and writing or no writing. An ANOVA showed that there was no significant difference between the four groups in terms of age ($p=0.37$), and chi-square analyses indicated that the four groups were equivalent for sex ratio ($p=0.88$), and for the probability of having one left-handed parent ($p=0.46$).

Handedness questionnaire for parents: The parents were given the handedness questionnaire that we developed, which comprised 15 items on manual preference [24]. All mothers and 42 fathers filled out the questionnaire (writing hand was known for 46 fathers).

Coding and analyses

The hand considered the grasping hand was the one that arrived at the object first and grasped it. Grasping was coded as bimanual when the two hands grasped the object simultaneously or almost simultaneously. In the writing condition, it was sometimes difficult for the experimenter to decide online whether the grasp was unimanual or bimanual: in these cases, the video recording was used to code the grasp, as in the no writing condition. In the video recording, a grasp was classified as bimanual when the two hands grasped the object within a maximum of three video frames: i.e., less than 120 ms apart. Results coded online by the experimenter in the writing condition, including for unimanual grasps, were also checked on the video recording. Inter-rater reliability was tested on the video recordings of five randomly selected participants. The comparisons indicated 100% inter-rater agreement for the hand used during unimanual grasping, and 96% agreement for unimanual *vs*. bimanual grasping.

A handedness index (HI) was calculated as follows: [(Number of RH grasps-Number of LH grasps)/(Number of RH grasps +Number of LH grasps+Number of Bimanual grasps)]. The percentage of right-hand, left-hand and bimanual grasping was also calculated. After checking the normality of the distributions, we used ANOVAs with HI as the dependent variable, and

condition, experimenter's handedness, gender, and parents' handedness as independent variables. Effect sizes were calculated using Cohen's d [25].

Almost all of the mothers (97.8%) and 80% of the fathers wrote with their right hand. The mothers' handedness index (HI=0.91) was significantly higher than that of the fathers (HI=0.69), t (88)=2.02, p=0.046. However, the effect is small, d=0.42. The mothers' mean HI did not differ between the four groups, p=0.63. Similarly, the HI of the father did not differ between the four groups, p=0.48.

Results

Infants' HI as a function of experimenter's handedness x condition

We checked the possible effect of the experimenter's use of her preferred hand to tick off the infant's response on a sheet of paper after each object presentation. As shown in Figure 1, the infants showed much less right-handedness in grasping the object in the writing than in the no writing condition. The unexpected result was that infants in the writing condition showed less right-handedness regardless of which hand the experimenter used to write. An ANOVA calculated on HI as a function of experimenter's handedness (right-handed *vs*. left-handed) and condition (writing *vs.* no writing) indicated a significant effect of condition, F(1,44)=5.72, p=0.021; Cohen's d=0.71, but no effect of experimenter's handedness, p=0.88, and no Condition x Experimenter's Handedness interaction, p=0.83. Thus, whatever hand the experimenter used to write, the infants in this condition showed a lower percentage of right-hand grasping compared to the no writing condition.

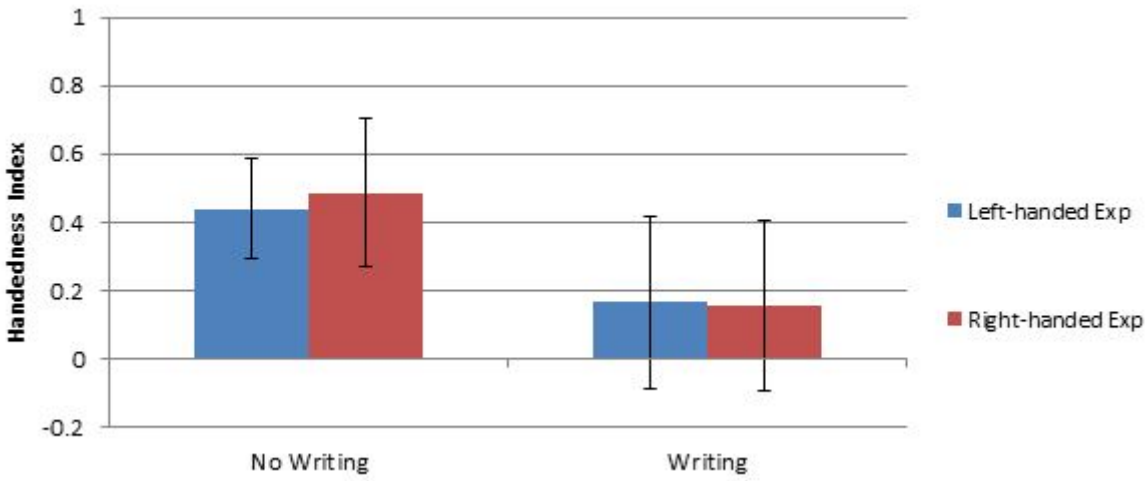

Figure 1: Handedness Index (HI) as a function of experimenter's handedness and use of her hand to write in front of the child during testing session

We then checked whether the infants' lower percentage of RH grasping was due to a higher percentage of LH grasping, a higher percentage of bimanual grasping, or both. Qualitatively, the right and left-handed experimenter writing groups seem to differ to a greater extent than the right and left-handed experimenter no writing groups (Figure 2). Regardless of the experimenter's handedness, infants have a lower percentage of right-hand grasping in the writing than in the no writing condition. But these lower percentages of right-hand grasping are mainly due to a higher percentage of left-hand grasping when the experimenter was left-handed, and to a higher percentage of bimanual grasping when the experimenter was right-handed. However, neither of these differences reaches significance (comparison of LH grasping with a left-handed experimenter in writing and no writing conditions, p=0.07; comparison of bimanual grasping with a right-handed experimenter in writing and no writing conditions, p=0.09).

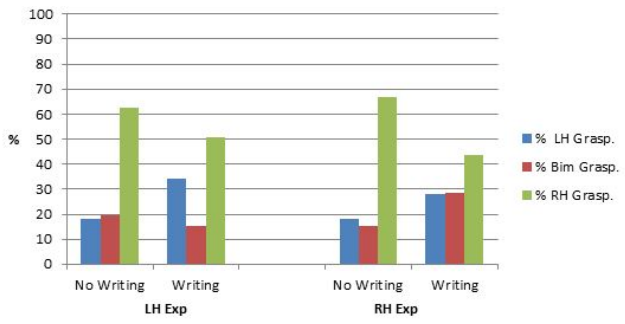

Figure 2: Percentages of left-hand, right-hand, and bimanual grasping as a function of condition (writing/no writing) and experimenter's handedness

Parents' handedness

We could not check whether the mother's handedness influenced the infant's HI because only two infants had a left-handed mother.

Nine infants had a left-handed father, and they were evenly distributed across the four groups (2 in each group except the writing+left-handed experimenter group, where there were 3). We were thus able to check whether father's handedness influenced the infants' HI and whether it would modulate the influences of the experimenter's handedness and of the condition. An ANOVA on HI indicated no main effect of father's handedness, p=0.53, and no significant Father's Handedness x Experimenter's Handedness interaction, p=0.87, Father's Handedness x Condition interaction, p=0.22, or Father's Handedness x Experimenter's Handedness x Condition interaction, p=0.98.

Sex

Girls' mean HI (0.38) was higher than that of boys (0.24), but this difference was not significant, p=0.28. We also checked for any difference in how boys and girls were influenced by the experimenter's handedness and the condition. An ANOVA on HI showed no main effect of sex, p=0.26. None of the interactions were close to significance: p=0.26 for Sex x Experimenter's Handedness, p=0.53 for Sex x Condition, and p=0.70 for Sex x Experimenter's Handedness x Condition.

Discussion

The goal of this study was to evaluate whether the experimenter's handedness influences the hand an infant chooses to grasp an object. Although experimenters are generally careful to handle objects neutrally (either bimanually, or counterbalancing the hand used to give the object to the infant), they may involuntarily give infants clues to their handedness nonetheless. We thought it useful to check whether an apparently incidental indication of hand preference given by the experimenter could bias the infant toward using the same hand. We thus compared the infants' handedness index (HI) depending on the experimenter's handedness (left-or right-handed for writing), and on whether or not the experimenter showed her handedness during the experiment by writing.

Our results show that the two conditions, writing and no writing, induced significantly different HIs. The infants' HI was significantly lower than when the experimenter used a pencil during the test, indicating that seeing the experimenter use her hand to write across the table significantly influenced the infants' choice of hand to grasp objects. In other words, the infants in the writing condition used their right hand less systematically than those in the no writing condition. When the experimenter did not use a pencil to record which hand the infant had used on each trial, after the infant had grasped the object but before handling the next one, the experimenter's handedness did not influence the infant's hand selection, as we hypothesized.

Contrary to our second hypothesis, the effect of seeing the experimenter use her hand to write across the table ran in the same direction with the left-handed and the right-handed experimenter, and was equally large in the two cases: infants from both groups used their right hand alone to grasp significantly less than did infants who did not see the experimenter write. There was a qualitative trend for the left-handed experimenter writing group to use more their left-hand to grasp the object, and for the right-handed experimenter writing group to grasp the object more bimanually, but these results did not reach significance.

The finding that seeing a left-handed experimenter use her own hand influences the infant's own hand use is in line with Fagard and Lemoine's results [18]. In a face-to-face situation, infants who were right-handed at the beginning of the test session used less their right hand and more their left hand after observing the demonstration of the left-handed experimenter. An adult study has also shown that motor-evoked potentials are larger in the right motor cortex when observing a movement made by the left hand [26]. This could explain why, after seeing the experimenter write with her left hand (writing condition), infants use less their right hand than infants in a no writing condition. However, the same study also showed that motor-evoked potentials in the left motor cortex are larger when observing a movement made by the right hand. Why then, in the present study, the infants in the right-handed experimenter writing group did not use their right hand more and their left-hand less than the infants from the right-handed experimenter no writing group? The fact that the effect seen in the right-handed experimenter writing group was not the reverse of the one seen in the left-handed experimenter writing group may indicate that part of the effect is non-specific: infants' choice of hand may be disturbed by seeing the experimenter write on a sheet of paper, without the resulting effect being specifically linked to the hand used by the experimenter. The lower HI in the writing condition compared to the no writing condition, regardless of the experimenter's handedness, may indicate that the results should be interpreted more in terms of disturbance and attention than in terms of the infant mirroring the adult. As mentioned in the introduction, right-handedness is neither strong nor stable in infants, and many factors may disturb its expression. Seeing an experimenter writing may be one of them. Another explanation of the fact that seeing a left-handed or a right-handed experimenter writing did not produce a reverse effect may be that using the "same" hand may mean the same hand spatially (spatially mirror, right hand when the experimenter uses her own left hand) or the same hand anatomically (anatomically mirror, left hand when the experimenter uses her own left hand). Some infants may be more sensitive to anatomical mirroring while others may be more sensitive to spatial mirroring.

Parents' handedness had no effect on the results. Finally, we checked for a possible sex effect. To our knowledge, there have been no studies on differential effects of factors influencing hand choice in human infants by sex. Only one animal study showed such a sex effect: in that study, male mice which had observed a "left-handed" mouse "teacher" open a pendulum door used their left paw to do the same, while males that had

observed a "right-handed" model used their right paw [27]. This effect was not observed in female mice. In our study, we found no effect of sex on the bias induced by the experimenter's writing with either hand. We only found an overall tendency for girls to be more right-handed, which agrees with most studies in children [28,29] and adults [30].

Beyond the practical implications of our results-namely, that researchers should be very careful to avoid potential bias when testing infants' hand preference-knowing how infants are influenced by the hand used by the adults they watch may have pedagogical and theoretical implications. From a pedagogical point of view, it is important to know how young infants are influenced by what they see in front of them, from the other's perspective. It has been shown that when observing a new tool use skill, 18-month-old infants learn a great deal just by observing adults performing the skill, more than by spontaneously manipulating the tool themselves or even by being given an explicit demonstration [22]. In that study, the adult used the tool in front of the infants without any comment. Quite often, infants see adults do things around them from the opposite perspective. Interestingly, when teaching children a very complex new skill such as tying their shoelaces or knitting, adults tend to adopt the child's perspective. By showing them how to perform the action from beside them, they not only induce them to use the same hand, but also create a situation where the anatomical coincides with the spatial: both the teacher's and the child's right hand is to the side of their body that is to the right from the child's point of view.

From a theoretical point of view, understanding to what extent the opposite perspective induces motor resonance in terms of spatial or anatomical mirroring is considered important for questions such as body image, theory of mind, action understanding, etc. This question of perspective and imitation is hotly debated, and it has been studied in various contexts, such as explicit imitation of simple gestures, observational learning of new multi-step actions, implicit resonance effect, etc. [31-34].

In conclusion, observing the experimenter writing during the session decreases infants' expression of right-handedness. Part of the effect may reflect some motor resonance, but attentional factors might be equally important. Further studies with more infants are needed to tease apart the respective influence of the experimenter's handedness (anatomical *vs.* spatial motor resonance) and of attentional bias in infants' hand choice for grasping.

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References

1. Hepper PG, Shahidullah S, White R (1991) Handedness in the human fetus. Neuropsychol 29: 1107-1111.
2. Hepper PG, Wells DL, Lynch C (2005) Prenatal thumb sucking is related to postnatal handedness. Neuropsychol 43: 313-315.
3. Fagard, J, Margules S, Lopez C, Granjon L, Huet V (2016) How should we test infant handedness? Laterality 22: 294-312.
4. Ferre CL, Babik I, Michel GF (2010) Development of infant prehension handedness: A longitudinal analysis during the 6- to 14-month age period. Infant Behav Dev 33: 492-502.
5. Michel GF, Ovrut MR, Harkins DA (1985) Hand-use preference for reaching and object manipulation in 6- through 13-month-old infants. Genet Soc Gen Psychol Monogr 111: 407-427.
6. Ramsay DS (1980) Onset of unimanual handedness in infants. Infant Behav Dev 3: 377-385.
7. Corbetta D, Thelen E (1999) Lateral biases and fluctuations in infants' spontaneous arm movements and reaching. Dev Psychobiol 34: 237-255.
8. Fagard J (1998) Changes in grasping skills and the emergence of bimanual coordination during the first year of life. Londres: Mac Keith Press. pp. 123-143.
9. Nelson EL, Campbell JM, Michel GF (2013) Unimanual to bimanual: Tracking the development of handedness from 6 to 24 months. Infant Behav Dev 36: 181-188.
10. Fagard J, Lockman JJ (2005) The effect of task constraints on infants' (bi)manual strategy for grasping and exploring objects. Infant Behav Dev 28: 305-315.
11. Jacobsohn L, Rodrigues P, Vasconcelos O, Corbetta D, Barreiros J (2014) Lateral manual asymmetries: a longitudinal study from birth to 24 months. Dev Psychobiol 56: 58-72.
12. Michel GF, Babik I, Sheu CF, Campbell JM (2014) Latent classes in the developmental trajectories of infant handedness. Dev Psychol 50: 349-359.
13. Fagard J, Jacquet AY (1996) Changes in reaching and grasping objects of different sizes between 7 and 13 months of age. Br J Dev Psychol 14: 65-78.
14. Esseily R, Jacquet AY, Fagard J (2011) Handedness for grasping objects and pointing and the development of language in 14-month-old infants. Laterality 16: 565-585.
15. Harkins DA, Uzgiris IC (1991) Hand-use matching between mothers and infants during the first year. Infant Behav Dev 14: 289-298.
16. Michel GF (1992) Maternal influences on infant hand-use during play with toy. Behav Genet 22: 163-176.
17. Harkins DA, Michel GF (1988) Evidence for a maternal effect on infant hand-use preferences. Dev Psychobiol 21: 535-541.
18. Fagard J, Lemoine C (2006) The role of imitation in the stabilization of handedness during infancy. J Integr Neurosci 5: 519-533.
19. Abravanel E, Levan Goldschmidt E, Stevenson MB (1976) Action imitation: The early phase of infancy. Child Dev 47: 1032-1044.
20. Meltzoff AN (1988) Imitation, objects, tools, and the rudiments of language in human ontogeny. Hum Evol 3: 45-64.
21. Elsner B, Hauf P, Aschersleben G (2007) Imitating step by step: a detailed analysis of 9- to 15-month-olds' reproduction of a three-step action sequence. Infant Behav Dev 30: 325-335.
22. Somogyi E, Ara C, Gianni E, Rat-Fischer L, Fattori P, et al. (2015) The roles of observation and manipulation in learning to use a tool. Cogn Dev 35: 186-200.

23. Hinojosa T, Sheu CF, Michel GF (2003) Infant hand-use preferences for grasping objects contributes to the development of a hand-use preference for manipulating objects. Dev Psychobiol 43: 328-334.

24. Fagard J, Chapelain A, Bonnet P (2015) How should "ambidexterity" be estimated? Laterality 20: 543-570.

25. Cohen J (1977) Statistical power analysis for the behavioral sciences. (1stedn), Lawrence Erlbaum Associates Inc, New Jersey, United States.

26. Aziz-Zadeh L, Maeda F, Zaidel E, Mazziotta J, Iacoboni M (2002) Lateralization in motor facilitation during action observation: a TMS study. Exp Brain Res 144: 127-131.

27. Collins RL (1988) Observational learning of a left-right behavioral asymmetry in mice (Mus musculus). J Comp Psychol 102: 222-224.

28. Annett M (1970) The growth of manual performance and speed. Br J Psychol 61: 545-548.

29. Davis A, Annett M (1994) Handedness as a function of twinning, age and sex. Cortex 30: 105-111.

30. Papadatou-Pastou M, Martin M, Munafo MR, Jones GV (2008) Sex differences in left-handedness: A meta-analysis of 144 studies. Psychol Bulletin 134: 677-699.

31. Mengotti P, Corradi-Dell'acqua C, Rumiati RI (2012) Imitation components in the human brain: an fMRI study. Neuroimage 59: 1622-1630.

32. Watanabe R, Higuchi T, Kikuchi Y (2013) Imitation behavior is sensitive to visual perspective of the model: an fMRI study. Exp Brain Res 228: 161-171.

33. Watanabe R, Watanabe S, Kuruma H, Murakami Y, Seno A, et al. (2011) Neural activation during imitation of movements presented from four different perspectives: a functional magnetic resonance imaging study. Neurosci Lett 503: 100-104.

34. Chiavarino C, Apperly IA, Humphreys GW (2007) Exploring the functional and anatomical bases of mirror-image and anatomical imitation: the role of the frontal lobes. Neuropsychol 45: 784-795.